Forest Service

Forest Pest
Management

Davis, CA

NATIONAL STEERING COMMITTEES FOR AERIAL APPLICATION OF PESTICIDES

REPORT NO. 2

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NATIONAL STEERING COMMITTEES FOR AERIAL APPLICATION OF PESTICIDES REPORT NO. 2

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PREFACE

In 1988, the Chief established national steering committees to be coordinated by Forest Pest Management Staff. The purpose of the committees is to focus expertise on the need for pilot tests for aerial application of pesticides and to develop an overall plan of action which could be executed by field units. Steering committees were identified to cover four subject matter areas: (1) defoliators of western conifers; (2) gypsy moth and other eastern forest defoliators; (3) insects of seed orchards; and (4) vegetation management.

The four reports contained herein represent findings and recommendations resulting from the first meeting of each committee. Appendices to the committee reports also are included. The utility of this report includes: analysis of cost/benefit; documentation of pest management needs and accomplishments relative to committee recommendations; background information for committee members, especially new members; and briefing and coordination document for cooperators.

The steering committees welcome comments and suggestions which can be forwarded to the Chief, Attn: Director Forest Pest Management, P.O. Box 96090, Washington, D.C. 20090-6090, (703) 453-9600.

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SECTION 1

SECOND REPORT

National Steering Committee for Application of Pesticides - Gypsy Moth And Other Eastern Defoliators

April 18, 1990

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FTS 460-1715

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I. INTRODUCTION

The meeting was held at the Holiday Inn, Ohio Center, Columbus, Ohio, on November 1-2, 1989.

A. Committee Members

Leah Bauer	NC/FIDR (E. Lansing, MI)
Leo Cadogen	FPMI (Sault Ste. Marie, Ontario)
Tony Chiotakis	North Carolina Department of Agriculture (Raleigh, NC)
John Cunningham	FPMI (Sault Ste. Marie, Ontario)
Don Henry	California Department of Food & Agriculture (Sacramento, CA)
Harold Flake	R-8/FPM (Atlanta, GA)
Michelle Frank	NA/FPM (Durham, NH)
Alice Jones	SE/FIDR (Athens, GA)
Win McLane	APHIS (Otis AFB, MA)
Mike McManus	NE/FIDR (Hamden, CT)
Steve Munson	R-4/FPM (Ogden, UT)
Max Ollieu	WO/FPM (Washington, DC)
Dick Reardon	NA/FPM/AIPM (Morgantown, WV)
Dan Twardus	NA/FPM (Morgantown, WV)
Barry Towers	PA Bureau of Forestry (Middletown, PA)
Jack Barry (Chair)	WO/FPM (Davis, CA)

Alice Jones and Dan Twardus were not in attendance. Copies of individual committee member reports by John Cunningham, Harold Flake, Win McLane, Steve Munson, Michelle Frank, and Barry Towers are enclosed in Appendix A.

B. Purpose of Committee

The purpose of the committee is to review, identify, and recommend needs for field tests, pilot projects, and demonstrations of aerial application of pesticides. Needs include those associated with

pesticides, application systems, techniques, and strategies that influence the USDA Forest Service's and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

C. Operating Guidelines

Operating guidelines generic to the four FPM national steering committees are enclosed in Appendix B. Supplemental to these guidelines the committee adopted two additional guidelines: 1. The committee shall on an annual basis consider input/recommendations from the National Gypsy moth/*Bacillus thuringiensis* (B.t.) committee (see Appendix C); and 2. On an annual basis the committee shall recommend tank mixes for suppression and eradication of gypsy moth.

II. RECOMMENDATIONS

A. Laboratory

1. Investigate relationship of drop size to drop number, potency and efficacy to control gypsy moth.

   High - NEFAAT

2. Investigate impact of B.t. and Dimilin on non-target organisms through conduct of literature searches, contacts with Forest Pest Management Institute (FPMI), and field studies.

   High - Mike McManus

3. Develop a plan to characterize B.t. and Dimilin tank mixes for physical properties, atomization, and evaporation.

   High - Jack Barry

4. Develop a plan to obtain spread factors for tank mixes used to control gypsy moth.

   High - Jack Barry

5. Investigate canopy architecture of eastern deciduous forests (shape, sub-canopies, density, leaf-area index, etc.) for input and enhancement of FSCBG aerial spray model.

   High - Mike McManus

6. Develop a carrier for Gypchek.

   High - Mike McManus

7. Develop a process leading to the commercial production of Gypchek.

   Medium - FIDR

8. Investigate the "Henderson" carrier as a suitable, and physically and biologically acceptable carrier for Gypchek and B.t. formulations.

Medium - Win McLane

9. Screen tank mixes for effects on automobile paint surfaces.

Low - Win McLane

10. Investigate enzyme link immunosorbant assay (ELISA) or other techniques for rapid on-site determination of tank mix potency.

High - Pat Shea

B. Field Tests

1. Conduct field test(s) to compare insect efficacy resulting from applications with rotary and hydraulic atomizers using operational tank mixes of B.t.

High
Priority 1 - NEFAAT

2. Conduct field test of Foray 48B comparing efficacy of 16 BIU applied 96 ounces per acre to 36 BIU applied 96 ounces per acre.

High
Priority 2 - Mike McManus

3. Conduct field test of Gypchek comparing efficacy of standard dose to two lower doses.

High
Priority 3 - Mike McManus

4. Conduct field test to compare efficacy of an operational tank mix of B.t. to a B.t. tank mix containing the "Henderson" carrier.

High
Priority 4 - Win McLane

5. Conduct field tests of lower doses and lower volumes of Dimilin.

High
Priority 5 - Win McLane

6. Conduct field test of Mycogen B.t. product Myx 8242 subject to obtaining an experimental use permit.

High
Priority 6 - Mike McManus

C. Demonstration Projects

1. Demonstrate control strategy of using multiple applications of Gypchek against small (50-75 acre) isolated infestations of gypsy moth.

   High - Win McLane

2. Evaluate capability of FSCBG aerial spray model to predict predict penetration of a B.t. spray into an oak canopy.

   High - Jack Barry

3. Demonstrate utility of the gypsy moth phenology model supported by Omni-Data weather monitoring system to predict application timing.

   High - Steve Munson

D. Pilot Projects

1. Conduct a pilot project to test Foray 48B, 36 BIU, applied undiluted at 96 ounces per acre to determine if the application can consistently reduce gypsy moth populations.

   High
   Priority 1 - AIPM

2. Conduct a pilot project to test efficacy under operational conditions Dipel 8AF, 20 BIU, applied undiluted at 40 ounces per acre.

   High
   Priority 2 - AIPM

E. Equipment, Models, and Technology Development

1. Investigate both ground and aerial application equipment systems and methods to control hemlock woolly aldegid.

   High - Michelle Frank

2. Investigate and demonstrate weather monitoring systems to support gypsy moth control projects and plan for personnel training in use of the systems.

   High - Harold Flake

3. Evaluate utility of FSCBG aerial spray model to predict canopy penetration model by comparing deposition predictions to observed prediction in eastern deciduous canopies.

   High - NEFAAT

4. Review aircraft guidance and treatment block marking methods and publish a report that outlines equipment, methods, and advantages and disadvantages of each method.

   High - MTDC

F. Administrative

1. Concurred with recommendation of the western defoliator steering committee to meet jointly in 1990. Harold Flake and Steve Munson agreed to host the meeting to be held in Salt Lake City, UT, November 6-8, 1990.

2. Recommend development of state-of-the-art guidelines on timing of pesticide treatments to control gypsy moth.

3. Recommend research on gypsy moth monitoring and application timing.

4. Recommend that the Dan Twardus gypsy moth monitoring data-base be made available annually to State cooperators and to this committee.

5. Recommend development and conduct of an east-wide pesticide-use training workshop annually for control of eastern defoliators.

6. Pesticide tank mix recommendations for 1990 suppression[1]:

Product[2]	BIU/Acre	Volume/Acre
Thuricide 32LV	16 - 20	96 - 128
Thuricide 48LV	"	"
SAN 415	"	"
Dipel 6L	"	"
Dipel 8L	"	"
Dipel 8AF	"	"
Foray 48B	"	"
Dimilin 25W	(3)	128

Footnotes:
(1) For eradication double treatment required.
(2) Stickers essential with oil-base tank mixes. For Thuricide, SAN 415, and Dipel use 2% Bond or 2% Plyac per volume. For Foray 48B use 2% Plyac or 2% NuFilm.
(3) Apply Dimilin @ 0.03 AI (2 oz) per gallon per acre.

III. ACCOMPLISHMENTS AND NEEDS

Summarized below are accomplishments related to 1988 committee recommendations.

A. Cooperative Field Experiments and Pilot Projects

1. Gypchek was pilot tested in Virginia against high population densities achieving population reductions, uncorrected, of 60 percent.

2. Novo Foray 48B, B.t., was field tested and results showed excellent control. (See Appendix A, Win McLane's report)

3. Undiluted Foray 48B (12 BIU and 32 ounces per acre; 24 BIU and 64 ounces per acre; and 36 BIU and 96 ounces per acre) provided population reduction, uncorrected of 85 percent, 47 percent and 97 percent respectively.

4. Efficacy of registered tank mixes as function of drop size and nozzle type (rotary vs hydraulic) was not field tested.

B. Technical

1. A Task Group composed of Jack Barry and Dick Reardon contracted for and produced a comprehensive literature review report on spray accountancy. The review covered three decades of U.S. Army chemical and biological agent testing. The report includes data on how much aerial spray volume was accounted for and how much spray drifted downwind. Copies are available from Jack Barry (916) 758-4600 or Dick Reardon (304)291-4891.

2. FPM/WO (Davis) has contracted Continuum Dynamics, Inc. to enhance and support technology transfer and field testing of the FSCBG aerial spray model. During the past year several reports were published, papers presented, and training sessions conducted.

3. FPM/WO, R-6, NA, and MTDC cooperated in use of the AGDISP model to predict swath widths for aircraft used to treat gypsy moth. A draft report will be available in December 1989 from NA.

4. Spray block identification and aircraft guidance continues to be a major problem. No field projects were conducted during 1989 to address this need.

5. Representative spread factors that consider variable drop spreading due to moisture are needed. No laboratory or field work was done on this problem. John Cunningham reported that FPMI determines the representative spread factor in the laboratory after the field work. This procedure includes simulating field conditions in the laboratory to mimic field conditions. Unfortunately, this after-the-fact procedure would not be useful to persons characterizing aircraft during operational projects.

C. Administrative

1. Guidelines for pilot testing have been prepared and extensively reviewed. A current draft will be incorporated in Forest Service Handbook (FSH) by Dennis Hamel and copies of the guidelines are available from Jack Barry (916)758-4600.

2. Guidelines for field testing have been prepared and extensively reviewed. A current draft is available from Pat Shea (916)758-4600.

3. A 5-year B.t. research and development program has not been developed.

4. Procedures are being developed by NA (Dan Twardus) to monitor gypsy moth suppression projects in the East. State cooperators expressed an interest in receiving copies of these monitoring reports. Copies are available from Dan (304)291-4133.

5. Jim Space and Max Ollieu have scheduled a visit to FPMI on December 19-20, 1989 to explore opportunities for closer ties between FPMI and FPM. (Note that the meeting was productive and that a Memorandum of Understanding is being drafted on cooperation between FPMI and Forest Pest Management.)

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Gypsy Moth and Other Eastern Defoliators met in Columbus, OH, November 1-2, 1989 to develop recommendations for field experiments and pilot projects to support management of gypsy moth and other eastern defoliators. The committee was composed of representatives from Canada, the States, and Forest Service (Research and S&PF). Committee members presented individual reports on field activities (field tests, pilot projects, and operational projects) conducted during 1989. Testing and related needs were discussed, and recommendations developed. The committee concurred with the Western Defoliator Steering Committee's recommendation to meet jointly with this committee in Salt Lake City, UT, November 6-8, 1990.

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APPENDIX A
J.C. Cunningham

EXPERIMENTAL AERIAL APPLICATION OF DISPARVIRUS FOR CONTROL OF GYPSY MOTH IN ONTARIO: REDUCED DOSAGE AND EMITTED VOLUME

Report to the Seventeenth Annual Pest Control Forum

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November 1989

EXPERIMENTAL AERIAL APPLICATION OF DISPARVIRUS FOR CONTROL OF GYPSY MOTH IN ONTARIO: REDUCED DOSAGE AND EMITTED VOLUME

Summary

Following successful Disparvirus trials in 1988 with a double application of $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) in an emitted volume of 10.0 L/ha, a reduced double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) was tested in emitted volumes of 10.0 L/ha and 5.0 L/ha. The 10.0 L/ha application was applied on three 10 ha plots and the 5.0 L/ha application on three 20 ha plots. Total treated area was 90 ha. The tank mix contained 25% v/v molasses, 10% w/v Orzan LS as a UV protectant and 2% v/v Rhoplex B60A spreader-sticker. A Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for the first application and a Piper Pawnee fitted with 6 Micronair AU 5000 atomizers was used for the second application 3 days later. Larvae were mainly in their first instar at the time of these applications. A further 3 plots were selected as untreated checks. Pre-spray gypsy moth egg mass densities ranged from 2,180/ha to 11,900 in the six treated plots and from 2,000 to 6,380 in the three check plots.

A detailed assessment involved pupal counts in burlap traps, pre-spray and post-spray egg mass counts, weekly records of the incidence of NPV in treated and check plots and estimates of defoliation of oak trees. High levels of virus infection were observed in samples collected 2 weeks post-spray with 71, 81 and 100% of the larvae infected in plots sprayed at 10.0 L/ha and 71, 91 and 97% in plots sprayed at 5.0 L/ha compared to 3, 4 and 5% naturally occurring infection in the check plots.

The number of pupae/m of burlap trap ranged from 13 to 99 in the check plots, 4 to 6 in the plots treated at 10.0 L/ha and 4 to 22 in plots treated at 5.0 L/ha. There were considerable (undefined) numbers of forest tent caterpillars in all the plots which increased the extent of defoliation. However, defoliation of oak was significantly less in all the treated plots compared to check plots with defoliation ranging from 75 to 82% in check plots compared to 28 to 46% in plots treated at 10.0 L/ha and 19 to 38% in plots treated at 5.0 L/ha. There was no significant difference in reduction of egg mass densities between the 10.0 L/ha and 5.0 L/ha treatments, but egg mass densities in both treatments were significantly lower than those in the check plots; population reductions in the 10.0 L/ha treatments, calculated using a modified Abbott's formula, were 79, 79 and 85% and in the 5.0 L/ha treatments were 80, 85 and 98%. Hence, an application volume of 5.0 L/ha is recommended for Disparvirus in preference to 10.0 L/ha. These trials also indicate that a reduction in dosage of Disparvirus from $2.5X10^{12}$ to 10^{12} PIB/ha may be feasible, although any further reduction would not be advisable.

Introduction

Aerial spray trials were conducted in Ontario in 1988 when a double application of $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) was applied to 3 plots in an emitted volume of 10.0 L/ha when larvae were mainly in their first instar. It is necessary to rear, infect, harvest and process about 1,000 gypsy moth larvae to produce a 1 ha dosage of $2.5X10^{12}$ PIB. Foliage protection and reduction in egg mass densities were outstanding following these applications in 1988, far exceeding the parameters regarded as acceptable. These parameters are defined as defoliation of less than 40% in treated blocks and reduction in egg mass densities to below a threshold level of 1,200 egg masses/ha; control measures are advocated above this level.

The dosage used in 1988 is quite high and the application volume of 10.0 L/ha, although widely used for virus applications, is considered unacceptably high for forestry applications in Canada. Hence, in 1989 it was decided to evaluate a lower dosage and a lower emitted volume. The dosage selected was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). It requires 400 gypsy moth larvae to produce this dosage which was applied in two different emitted volumes, 10.0 L/ha, the same as used in 1988, and 5.0 L/ha.

Experimental plots and spray application

Six treatment plots and three check areas were selected in Lindsay District. Two treated plots were on Otonobee Conservation Authority property near Clear Lake, north of Lakefield and one check plot was on private land nearby. The remaining four treated plots and two check areas were on Duro Conservation Authority land and private land near Round Lake, north of Havelock.

Table 1. Meteorological conditions during spray applications.

Date	Air temp (°C)	Ground temp (°C)	% RH	Wind (km/h)
24 May	14-15	13-14	80-85	1-2
27 May	9	8	78-84	5-8

Table 2. Larval development at time of application.

Plot	Application	%L1	%L2	%L3
1	1	99.1	0.9	-.-
	2	86.3	13.7	-.-
2	1	100.0	-.-	-.-
	2	94.6	5.4	-.-
3	1	90.2	9.8	-.-
	2	51.1	41.1	7.8
4	1	100.0	-.-	-.-
	2	70.6	27.4	2.0
5	1	91.1	7.1	1.8
	2	56.0	38.0	6.0
6	1	98.2	1.8	-.-
	2	94.5	5.5	-.-

Table 3. Spray deposit on Kromekote cards.

Plot	Application number	NMD (μm)	VMD (μm)	Dmax (μm)	#Droplets/ cm^2 (± SE)
2	1	48	278	461	3.8 ± 2.5
	2	105	241	597	18.5 ± 16.3
3	1	61	370	938	63.6 ± 27.3
	2	109	303	734	43.3 ± 24.3
4	1	29	158	427	21.5 ± 8.7
5	1	23	248	392	22.6 ± 10.6
	2	101	347	665	10.0 ± 8.0
6	1	40	283	495	64.4 ± 37.0
	2	144	291	631	9.8 ± 3.5

The same dosage was applied to all 6 plots. It was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). Two different emitted volumes were tested, 10.0 L/ha and 5.0 L/ha. Plots treated at 10.0 L/ha (designated 1,2,3) were 10 ha and plots treated at 5.0 L/ha (designated 4,5,6) were 20 ha in area. Hence, a total area of 90 ha was sprayed with Disparvirus in 1989. The tank mix contained 25% v/v molasses, 10% Orzan LS, a lignosulphonate used as a UV protectant, and 2% v/v Rhoplex B60A spreader-sticker. The first spray on May 24th was applied by the FPMI Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers. The second spray, 3 days later, on May 27th was applied by a Piper Pawnee fitted with 6 Micronair AU 5000 rotary atomizers. Meteorological conditions during the applications are given in Table 1. Gypsy moth larval development is given in Table 2. Oak leaves were about 50% expanded on red oak and 25% expanded on white oak at the time of application. Kromekote cards were placed at 15 m intervals at right angles to flight lines in some of the plots where this was practical. Results of the analysis of these cards is given in Table 3, although there may be anomolies due to masking of some cards by foliage and spray drift away from the card line.

Assessment

Egg mass counts were made on ten 10 m^2 (0.01 ha) sub-plots in each treated and check plot using methods established by Forest Insect and Disease Survey staff. Numbers were converted to egg masses per hectare. Counts were made in early May before hatching commenced and the same plots were re-examined in mid-October. Reduction in egg mass density was calculated using a modified Abbott's formula; treated and check plots with corresponding pre-spray egg mass counts were paired for this calculation.

Incidence of virus infection was estimated pre-spray, between the two spray applications and at weekly intervals post-spray in all the treated and check plots. Random samples of larvae were collected at eye level on understory vegetation (100 to 200 per plot), smeared on microscope slides, stained with naphthalene black 12B and examined at 1,200X magnification for the presence of PIBs. Larvae were not collected in the vicinity of the 0.01 ha sub-plots used for egg mass counts.

Pupal counts were made from burlap traps on three oak (red or white) trees in each of the ten 0.01 ha plots used for egg mass counts in all the treated and check plots. Strips of burlap, 450 cm wide, were folded double and nailed to the trunks of trees. The circumference of sample trees was measured and pupal counts converted to numbers-per-metre of burlap trap. These counts were made on July 11 and 12 at 7 weeks post-spray.

Defoliation estimates were made on 10 red oak or white oak 46-cm branch tips collected at mid-crown from trees in the ten 0.01 ha egg-mass sampling plots. This was done at 7 weeks post-spray when larvae had ceased feeding and were either pupating or dead. A total of 100 branch tips was examined in each treated and each check plot. An estimate of the amount of foliage missing from each branch was made and a mean calculated for each plot.

Results

Incidence of virus infection in the 6 treated and three corresponding check plots is shown in Fig. 1. Peaks of NPV infection were reached 2 weeks post-spray in the 6 treated plots and ranged from 71% to 100% of the larvae infected in the samples. Only 3 to 5% of larvae in the check plots were infected. Incidence of virus infection then dropped until 6 to 7 weeks post-spray when it again increased. At this time high levels were also recorded in the check plots, ranging from 50 to 94% of larvae infected. As pupation had commenced, figures for incidence of virus infection can become distorted because healthy larvae have pupated and a high percentage of the remaining larval population is infected.

Pupal counts are given in Table 4. Significant differences were recorded in numbers from the treated plots and corresponding check plots. Numbers of pupae/m of burlap trap ranged from 21 to 93 in the check plots and from 4 to 27 in the treated plots.

Egg mass counts in the spring and fall are given in Table 4 along with the population reductions due to treatment calculated using a modified Abbott's formula. Population reductions in the 3 plots sprayed at 10.0 L/ha were 79, 79 and 85% and in the 3 plots sprayed at 5.0 L/ha were 80, 85 and 98%. The results with the 5.0 L/ha treatment were marginally better than the 10.0 L/ha treatment, but this difference is not statistically significant.

Defoliation estimates are also given in Table 4. There was a significant difference in the degree of defoliation between all treated and check plots. However, results were confounded by moderate to high populations of forest tent caterpillar, *Malacosoma disstria*, in all nine plots, although it was impossible to quantify population densities. Defoliation in the three untreated check plots ranged from 75 to 82% and in the six treated plots ranged from 19 to 46%.

Discussion

The reductions in dosage and emitted volume tested in 1989 are considered effective and both are most desirable achievements if Disparvirus is to become an operational pest management alternative for gypsy moth control. The applications at 5.0 L/ha were marginally better than those at 10.0 L/ha. This is possibly due to better atomization of droplets by Micronair units at the reduced flow rate. Due to the negligible difference between the two application volumes, all six plots treated with the same dosage can be compared as replicates. Of these 6 replicates, three were excellent, two were borderline and one did not meet the criterion of a reduction in egg mass densities to below 1,200/ha. However, in this plot, egg mass density was reduced from 11,900/ha to 2,200/ha which, in itself, was a major accomplishment. Perhaps Disparvirus applications are not so effective on gypsy moth population densities in excess of 8,000 to 10,000 egg masses per hectare. One should possibly consider Disparvirus applications two years in

Fig. 1. Incidence of NPV-infected larvae in plots treated with Disparvirus and in corresponding check plots.

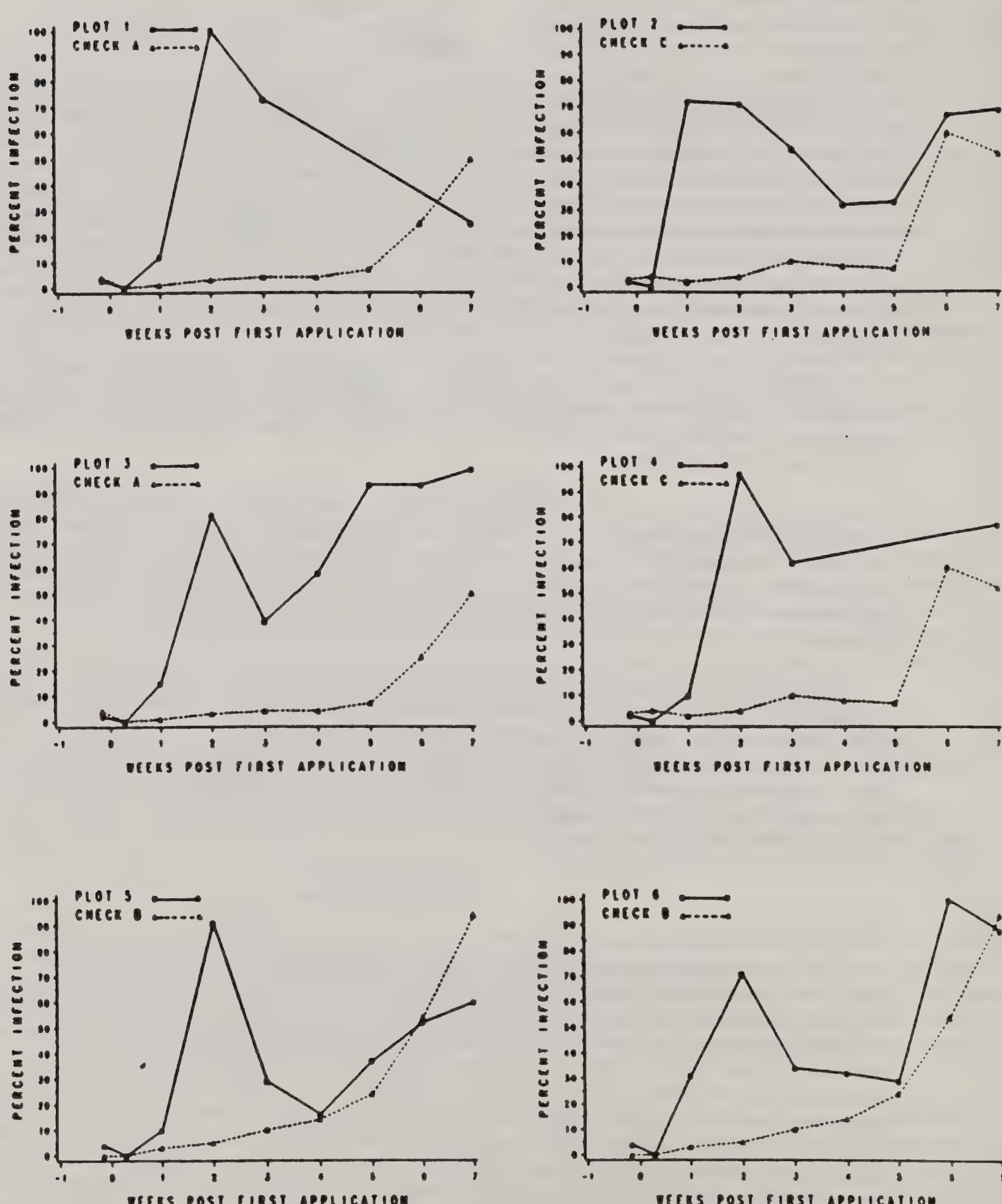

Table 4. Assessment of Disparvirus aerial spray trials.

Plot	Emitted volume (L/ha)	Pupae/m burlap (±S.E.)	Pre-spray E.M./ha (±S.E.)	Post-spray E.M./ha (±S.E.)	% Population reduction due to treatment[1]	% Defoliation of oak
Plot 1	10.0	27±9	2990±326	1130±246	79	46
Check A	-	93±14	2920±407	5320±1193	-	75
Plot 2	10.0	9±3	2180±199	370±106	85	28
Check C	-	21±3	2000±215	2230±414	-	82
Plot 3	10.0	4±1	3170±575	1230±392	79	28
Check A	-	93±14	2920±407	5320±1193	-	75
Plot 4	5.0	10±2	2490±258	540±176	85	38
Check C	-	21±3	2000±215	2230±414	-	82
Plot 5	5.0	22±8	11900±3778	2220±1190	80	28
Check B	-	91±13	6380±1877	5810±888	-	81
Plot 6	5.0	4±1	6730±1579	150±32	98	19
Check 5	-	91±13	6380±1877	5810±888	-	81

[1] Calculated using a modified Abbott's formula.

succession when attempting to control very high density gypsy moth populations.

It is difficult to apply the parameter set for foliage protection in these trials because of undetermined defoliation attributed to forest tent caterpillar in the whole general area. However, defoliation was significantly lower in all the treated plots compared to the check plots and the Disparvirus treatments had an obvious and clearcut impact in saving oak foliage. Only one treated plot did not meet the guideline of under 40% defoliation. This was plot 1 with 46% defoliation; obviously without the intervention of forest tent caterpillar, it too would have been classified as adequately protected.

Some of the very high levels of virus infection recorded two weeks post-spray, followed by moderate pupal and egg mass counts, leads one to doubt the validity of this means of assessment. One would have anticipated virtual eradication of the population and this did not occur. Larvae that were sampled at eye level on understory vegetation were almost all infected with NPV in some samples. This leads one to ask two questions 1) should samples of larvae have been collected from mid-crown or higher in the trees and 2) were the treated plots re-infested by larvae from adjoining, heavily defoliated areas?

Conclusions and recommendations

From the above results, it is evident that an emitted volume of 5.0 L/ha is as good as, if not better than, 10.0 L/ha, provided it is applied using Micronair rotary atomizers or equipment giving a similar droplet spectrum. A further reduction in emitted volume should be investigated and it is hoped to compare 2.5 L/ha to 5.0 L/ha in 1990.

The double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) applied in 1989 is considered to be the lowest feasible dosage and lower dosages are not recommended. In fact, a higher dosage is desirable, but economic factors come into play. It is necessary to rear, infect, harvest and process 400 gypsy moth larvae to produce 10^{12} PIBs. How much will this cost? Is it competitive with *Bacillus thuringiensis*? These questions are academic until Disparvirus (or another viral insecticide for gypsy moth) is commercially available.

FPMI staff is in contact with two companies who are interested in producing a viral insecticide for gypsy moth. The first is Espro, located in Maryland, USA and the second is Calliope, in France. At present, it appears improbable that either company will have a product available for field trials in Canada in 1990. Hence, any field trials conducted next year will use Disparvirus produced at FPMI.

This research was funded in part by an Ontario Pesticides Advisory Committee grant.

DEPOSITION AND EFFICACY OF DIPEL 8AF APPLIED DILUTED AND UNDILUTED AGAINST THE GYPSY MOTH (LEPIDOPTERA: LYMANTRIIDAE) IN SOUTHEASTERN ONTARIO

Information Report FPM-X-84
1989

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Cette publication est aussi disponible en français sous le titre: *Caractéristiques du dépôt et efficacité du Dipel 8AF, en solution ou non, contre la spongieuse (Lepidoptera: Lymantriidae) dans le sud–est de l'Ontario.*

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Van Frankenhuyzen, K., Howard, C., Churcher, G., Howse, G., Lawrence, D. 1989. Deposition and efficacy of Dipel 8AF applied diluted and undiluted against the gypsy moth (Lepidoptera: Lymantriidae) in southeastern Ontario. Forestry Canada, Sault Ste. Marie, Ont. Forest Pest Management Institute Inf. Rep. FPM-X-84, 11 p.

ABSTRACT

The feasibility of ultra-low volume application of undiluted *Bacillus thuringiensis* formulations for control of the gypsy moth was examined by treating three oak stands with Dipel 8AF at 15 BIU in 0.9 L/ha (undiluted) or at 30 BIU in 1.8 L/ha (undiluted) and 6.0 L/ha (diluted). Branches were collected from upper, middle and lower canopy and assayed for spray deposits as well as toxicity to third-instar gypsy moth larvae. Droplet size distributions in the two undiluted treatments were similar with a number median diameter (NMD) of 49-55 μm and a volume median diameter (VMD) of 117-126 μm. The diluted application resulted in a broader size distribution, with an NMD of 98 μm and a VMD of 180 μm. Droplet density was significantly higher in the 1.8 and 6.0 L/ha treatments (5-10 droplets/cm^2) than in the 0.9 L/ha treatment (3-5 droplets/cm^2). Droplet density decreased significantly from upper to lower canopy in each spray block. Mortality of gypsy moth larvae in the bioassays reached about 50% in the 1.8 and 6.0 L/ha treatments and 30% in the 0.9 L/ha treatment. Regression analysis of mortality versus observed droplet density in the bioassays did not differ between treatments. For both diluted and undiluted applications, a density of 8-10 droplets/cm^2 was required to obtain 50% mortality. All treatments resulted in lower defoliation and egg mass density than in untreated areas, but declining populations confounded the assessment. Application of undiluted formulations containing 16.9 BIU/L in 1.8 L/ha can be recommended for operational control of gypsy moth. The feasibility of using higher potency products in even lower volumes needs to be assessed in future programs.

RÉSUMÉ

La possibilité d'appliquer en très faible volume des formulations non diluées de *Bacillus thuringiensis* pour lutter contre la spongieuse a été examinée : on a traité trois peuplements de chênes avec du Dipel 8AF à 15 UBI par 0,9 L/ha (forme non diluée) ou 30 UBI par 1,8 L/ha (forme non diluée) ainsi que 6,0 L/ha (forme diluée). Des branches ont été prélevées aux niveaux supérieur, intermédiaire et inférieur de la cime; les dépôts laissés par pulvérisation ainsi que la toxicité chez les larves du troisième stade de la spongieuse ont été étudiés. La distribution par taille des gouttelettes était semblable dans les deux traitements avec le produit non dilué, soit avec un diamètre médian en fonction du nombre (DMN) de 49-55 μm et un diamètre médian en fonction du volume (DMV) de 117-126 μm. L'application du produit dilué a eu pour effet d'élargir la distribution des gouttelettes; le DMN était de 98 μm et le DMV était de 180 μm. Il y avait une densité significativement supérieure des gouttelettes lors des traitements à 1,8 et 6,0 L/ha (5-10 gouttelettes/cm^2) que lors du traitement à 0,9 L/ha (3-5 gouttelettes/cm^2). Il y avait une réduction significative de la densité des gouttelettes du niveau supérieur au niveau inférieur de la cime dans chaque parcelle traitée. Lors des essais biologiques, la mortalité des larves de la spongieuse se chiffrait à environ 50 % dans les groupes traités à 1,8 et 6,0 L/ha et atteignait 30 % dans le groupe traité à 0,9 L/ha. Il n'y avait pas de différence entre les différents traitements quant à l'analyse par traitements et quant à l'analyse par régression de la mortalité dans les bioessais par rapport à la densité observée des gouttelettes. Que ce soit sous forme diluée ou non, il fallait une densité de gouttelettes de 8-10 gouttelettes/cm^2 pour atteindre une mortalité de 50 %. Tous les traitements ont atténué la défoliation et diminué la densité des masses d'oeufs, par rapport aux secteurs-témoins, mais les populations généralement faibles de larves n'ont pas aidé à l'évaluation. L'application de formulations sous forme non diluée et contenant 16,9 UBI/L dans 1,8 L/ha peut être recommandée pour les traitements opérationnels de la spongieuse. Il est suggéré de vérifier la possibilité d'utiliser des produits plus actifs et un volume encore moindre lors des futurs programmes.

INTRODUCTION

Bacillus thuringiensis Berliner is widely used for control of the gypsy moth, *Lymantria dispar* L., in eastern North America. Aerial control operations usually involve application of diluted formulations in 6-9.5 L/ha (Grimble and Lewis 1985). Such high volume application rates were used for control of the eastern spruce budworm, *Choristoneura fumiferana*: high-potency formulations became available in the early 1980s (Morris 1984). These formulations contain 12.7 Billion International Units (BIU)/L or more and can be applied undiluted at 30 BIU/ha in 2.4 L or less. Application of undiluted formulations has substantially reduced costs of spruce budworm control operations (Irland and Rumpf 1987), and would have similar benefits in gypsy moth control programs.

Ultra-low volume (ULV) application requires efficient atomization of the spray formulation into small droplets. Micronair rotary atomizers can generate a high proportion of droplets <100 μm in diameter from undiluted high-potency formulations (Yates and Cowden 1986; Van Vliet and Picot 1987). Such droplets impinge effectively on coniferous foliage (Picot et al. 1986) and are efficacious against several defoliators at densities of one droplet per needle or less (Fast et al. 1986; West et al. 1987; Cadogan et al. 1986). However, data are needed on deposition of small droplets in a hardwood canopy and their effectiveness against hardwood defoliators.

A cooperative study was initiated in 1987 to examine droplet deposition and distribution in relation to droplet size in an oak forest canopy following application of diluted and undiluted formulations. The study involved the Forest Pest Management Institute (FPMI) of Forestry Canada, the New Brunswick Research and Productivity Council (RPC) and Abbott Laboratories. The study was continued in 1988 in cooperation with the Pest Management Section of the Ontario Ministry of Natural Resources (OMNR) and the Forest Insect and Disease Survey (FIDS) of Forestry Canada. Specific objectives were: (1) to examine droplet deposition in an oak canopy in relation to application volume under operational spraying conditions; (2) to relate observed spray deposits to gypsy moth mortality in bioassays of sprayed foliage; (3) to assess efficacy of diluted and undiluted treatments in terms of foliage protection and egg mass reduction; and (4) to examine feasibility of undiluted application at half the recommended application rate. These objectives were addressed by treating six blocks at 30 or 15 BIU/ha in 0.9 L (three replicates), 1.8 L (two replicates) or 6.0 L (one replicate). The Pest Management Section was in charge of spray application. Spray deposition was assessed by RPC in each spray block and is the subject of a separate report. Biological assessment was conducted by FIDS and FPMI in the three blocks that had suitable gypsy moth populations, one in each treatment, and those results are reported here.

MATERIALS AND METHODS

Research Site

The experiment was conducted in May 1988 in Lavant Township in southeastern Ontario (Fig. 1). The selected blocks (50 -230 ha) contained predominantly red oak (*Quercus rubra* L., 60-90%) and red maple (*Acer rubrum* L., 10-40%), with a light mix of white birch (*Betula papyrifera* Marsh.), poplar (*Populus balsamifera* L.), balsam fir (*Abies balsamea* L.), and sugar maple (*A. saccharum* Marsh.). Dominant trees were generally 15-20 m in height. In each block a total of 15 oak trees were selected at 20-40 m intervals in a line perpendicular to flight direction of the spray aircraft. Crown height of the sample trees varied between 12 and 18 m.

Gypsy moth infestation in the three blocks was first detected in 1986. Populations in block A and B were high enough (>1200 egg masses/ha) to warrant aerial treatment with *B. thuringiensis* in 1987. Block B was scheduled for treatment in 1988 as well and OMNR agreed to allocate half of the 700 ha spray block, with appropriate buffer zones, to our experimental program. Block C formed a natural extension of the infestation in block B.

Application

All blocks were treated with Dipel 8AF (ABG 6167), which is an aqueous flowable formulation produced by Abbott Laboratories (Chicago, Ill.) that contains 16.9 BIU/L. To facilitate deposit assessment, Erio acid red dye XGN250 (St. Lawrence Aniline, Brockville, Ont) was added as a tracer at 0.4% (weight:volume). The mixture was applied by a Piper Brave fitted with four Micronair AU4000 atomizers. The aircraft flew 15-25 m above the canopy at 180 km/h using 60-m lane separations and was guided by a Cessna 172 pointer aircraft. Both planes operated from a private airstrip at Westport. Dipel was applied undiluted in 1.8 L/ha (block A) and 0.9 L/ha (block B) or diluted with water in a 1:2.33 ratio in a total volume of 6.0 L/ha (block C). Sprays were applied under standard operational conditions in the early morning (Table 1).

Deposit assessment

Distribution of spray deposits in the canopy was examined by sampling at three canopy levels. The crown of each sample tree was visually divided into an upper, middle and lower level. Starting one hour after application, one branch was collected from each level with a pole pruner and five twigs were taken from each branch. Cut ends of the twigs were wrapped in wet cotton and aluminum foil. Twigs were then placed individually in plastic boxes and transported in coolers to a field laboratory at the airstrip for assessment of deposits and biologi-

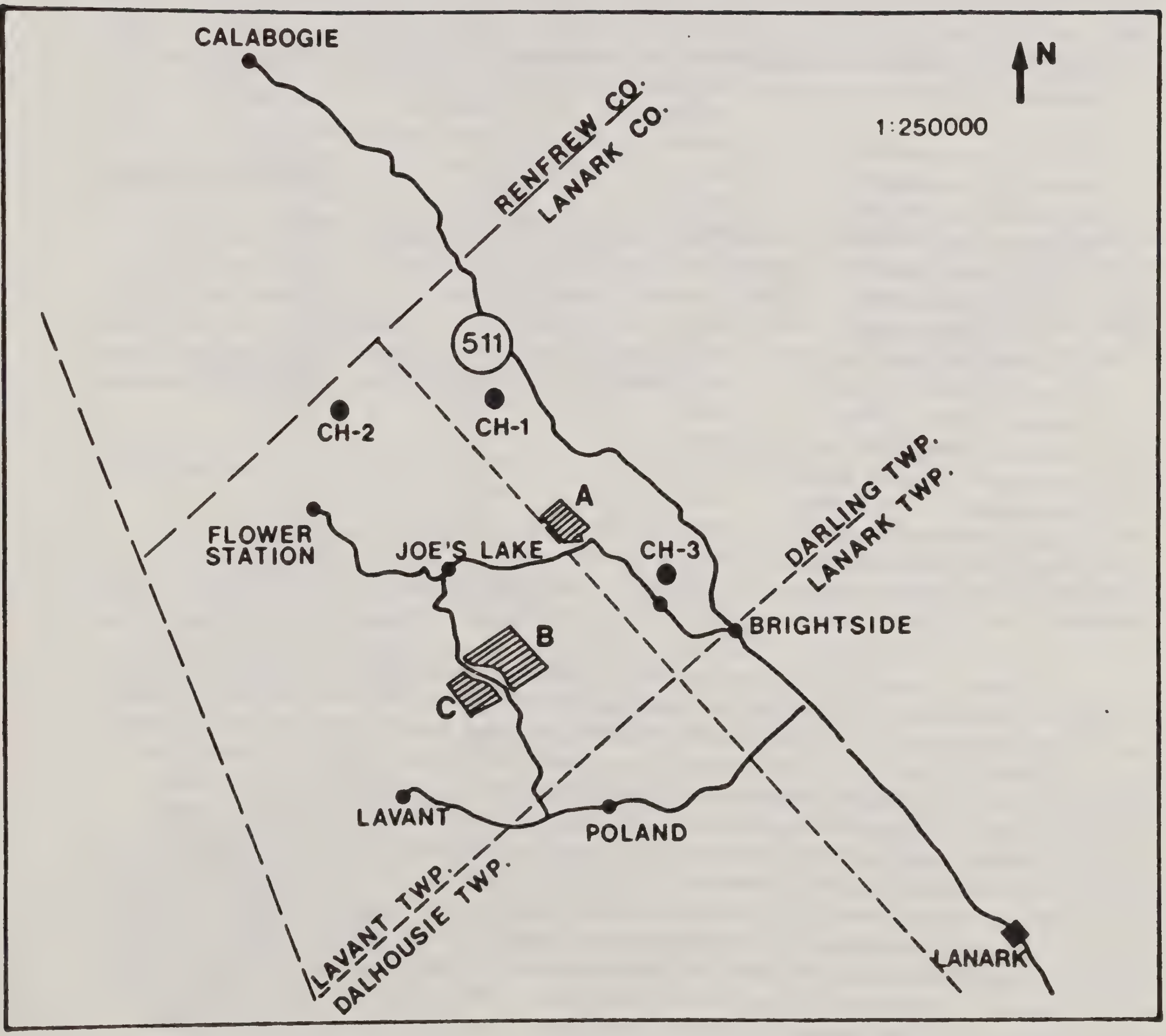

Figure 1. Location of the spray blocks (A, B and C) and untreated checks (1: Napier Hill; 2: Clyde Lake Mountain; 3: French Line) in southeastern Ontario.

cal activity. Spray deposits were estimated by examining one leaf from each twig under the microscope within 5 h of collection. The number of droplets were counted in five randomly selected fields of view for a total of 1.6 cm^2 per leaf surface. Droplet size was estimated by measuring 500 droplets in each treatment, using a Wild Leitz digital length measuring unit (Wild Heerbrug, Willowdale, Ont).

Table 1. Summary of application parameters

	Block A	Block B	Block C
Date of treatment	May 26	May 28	May 27
Size of block (ha)	70	230	50
Foliage expansion	75%	80%	60%
Instar development:			
% first instar	11	10	10
% second instar	46	74	74
% third instar	43	16	16
Time of application	0630-0645	0615-0645	0600-0645
Volume rate (L/ha)	1.8	0.9	6.0
Dosage rate (BIU/ha)	30	15	30
Micronair blade angle	35	35	35
Emission rate (L/min)	33.3	16.6	111
Pressure (psi)	29	38	26
Variable Restrictor #	11	7	bypass

Droplet density estimates were combined for the 15 sample trees in each spray block to obtain an average value from 75 leaves per canopy level. Variation in droplet density among spray blocks and canopy levels was examined by two way analysis of variance (ANOVA). Droplet densities were subjected to log transformation to approach a normal probability distribution. Pairwise, pooled variance t-tests with Bonferroni probabilities were used to compare treatment means within each block (Dixon 1983). The number median diameter (NMD) and volume median diameter (VMD) for each treatment were calculated according to Johnstone (1978). Spray deposits in the undiluted treatments consisted primarily of spherical or hemisperical droplets, indicating complete or near-complete evaporation. Spray deposits in the diluted treatment more than 100 μm in diameter consisted mostly of stains. Stain diameters are reported without conversion to actual droplet diameter.

Bioassay

Biological activity of spray deposits was examined by bioassay of the twigs collected from the three canopy levels. Each twig was placed in a ventilated plastic cage (18 x 8.5 x 4.5 cm) with its cut end in

water and received five early-to-mid third-instar larvae. Larvae came from egg masses that were collected in the fall of the previous year at Rice Lake (Peterborough, Ont). Cages were kept outside, sheltered from rain and direct sunlight. Larvae were transferred to unsprayed foliage on the fourth day and examined for mortality thereafter at 3-4 day intervals until cumulative mortality had stabilized (15-17 days). Natural mortality in cages was determined on 10 twigs collected from unsprayed trees on each treatment day. Larval mortality at each canopy level was related to observed droplet density for three groups of 5 sample trees each (n=15).

Egg mass survey

Egg mass densities were assessed in April and October, using 8 or 9 randomly selected modified Kaladar plots (MKP). These plots consist of 10 x 10 m squares. Egg masses were counted on all tree boles within this area and on the ground in 10 subplots of 1 x 1 m. The reduction in egg mass density was compared with the reduction observed by FIDS in three nearby untreated check blocks (Fig. 1).

Defoliation

Defoliation estimates were conducted by FIDS in late July. One 45-cm branch was collected from the midcrown of 10 trees in each of the MKP's. Defoliation was estimated by scoring the degree of defoliation of each leaf on the branch. Defoliation in the treated blocks was compared with estimates obtained from the three control blocks.

RESULTS AND DISCUSSION

The overall objective of this study was to assess the feasibility of applying undiluted *B. thuringiensis* for gypsy moth control. In 1987 we concluded that ULV application results in more uniform distribution of spray deposits within the canopy, due to better canopy penetration by smaller droplets, and equivalent mortality of gypsy moth larvae when compared to application of diluted product at higher volumes (van Frankenhuyzen et al. 1989). Results of the 1988 study generally support these observations.

The deposit data reported here are based on only one spray block per treatment. Estimates for the other blocks will be reported by RPC at a later date. Preliminary observations based on our data are reported here.

Mean droplet densities were significantly affected by spray treatment and position in the canopy (Table 2). Application of 6.0 and 1.8 L/ha resulted in comparable droplet densities, which were about 2-

fold higher than in the 0.9 L/ha treatment (Fig. 2). Distribution of spray deposits varied significantly within the tree canopy (Table 2). None of the treatments resulted in a uniform distribution of spray deposits throughout the canopy; droplet densities in the upper canopy were always significantly higher than in the lower canopy (Fig. 2). However, the difference between upper and middle canopy was largest in the 6.0 L/ha treatment and was not significant in the two undiluted treatments, despite more advanced expansion of foliage at the time of treatment, suggesting that undiluted application may have resulted in better canopy penetration.

Table 2. Analysis of variance for droplet density on upper and lower leaf surface combined

Source of variation	df	*F*	*P*-value
spray treatment	2	33.3	0.000
canopy level	2	18.0	0.000
spray x canopy	4	1.9	0.102
error	640		

Droplet size distributions were similar in the two undiluted sprays. More than 85% of all droplets were less than 100 μm in diameter (Fig. 3, blocks A and B), resulting in an NMD of 49-55 and a VMD of 117-126 μm. Size distribution in the 6.0 L/ha treatment was broader, with about 55% of all droplets under 100 μm and a larger NMD (98 μm) and VMD (188 μm) (Fig. 3, block C).

Spray deposits in the 1.8 and 6.0 L/ha treatments resulted in comparable mortality of third-instar gypsy moth larvae in the bioassays (respectively 46.1±2.4% and 51.0±3.3%, block average ± SE, n=45). Lower spray deposits in the 0.9 L/ha treatment resulted in significantly lower mortality (30.4±3.2%). Larval mortality on unsprayed foliage never exceeded 5%. Mortality decreased from upper to lower canopy similar to the observed distribution of spray deposits (Fig. 2). There was a linear relationship between mean mortality and mean droplet density on the twigs in each treatment. The relationship was weakest in block C. Regression lines did not differ significantly in either slopes or intercepts (ANOVA of regression coefficients: P=0.213) and were adequately described by a common line (Table 3). A density of 8-10 droplets/cm² was the estimated requirement for 50% mortality. In the 1987 study we obtained a similar estimate for Dipel 8AF applied at 1.8 L/ha but a much higher LD_{50} for application of diluted product (van Frankenhuyzen et al. 1989). The reason for this difference is not readily apparent.

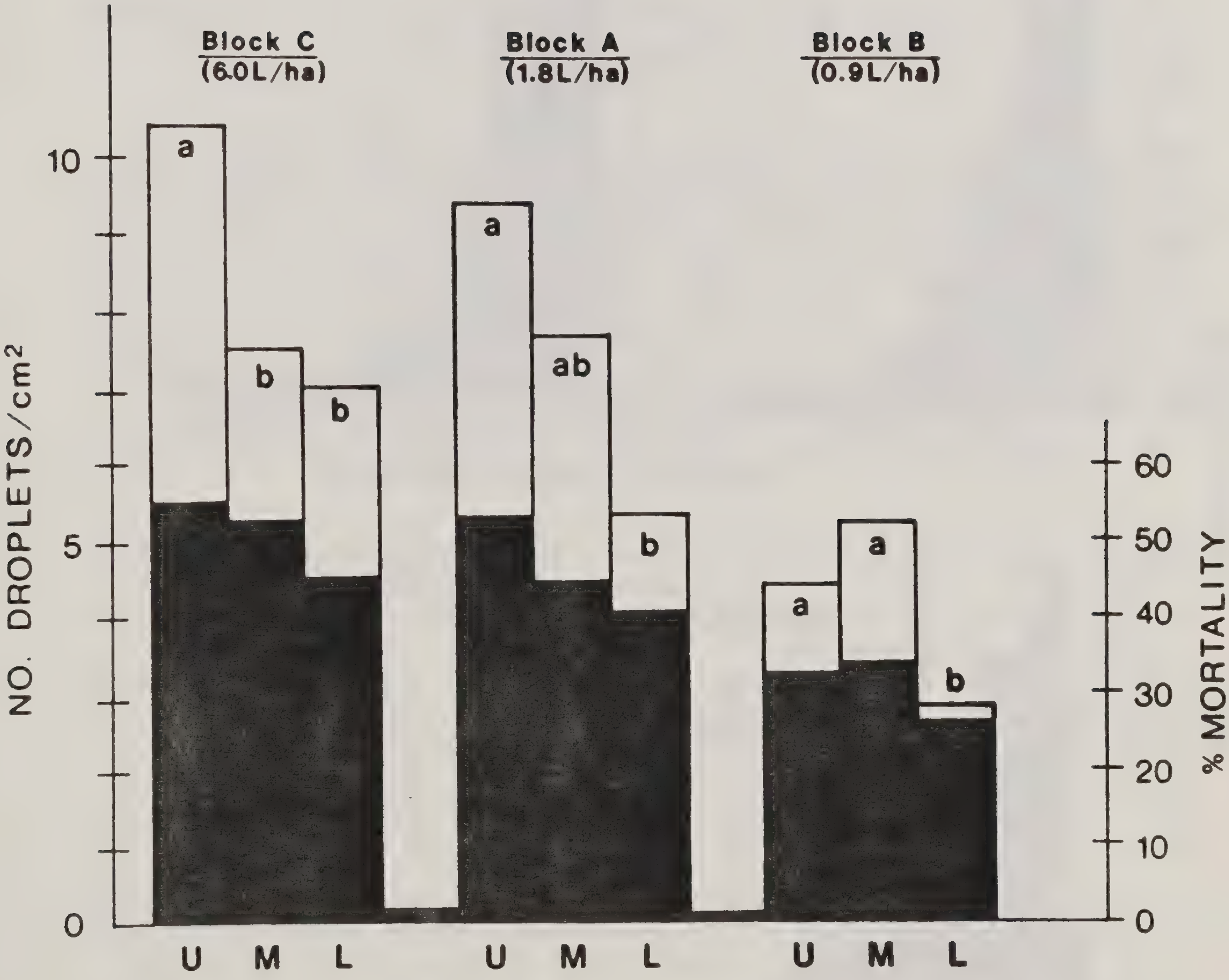

Figure 2. Mean number of spray droplets per cm² (open bars) and resulting mortality of third-instar gypsy moth larvae (solid bars) in bioassays of foliage collected from the upper (U), middle (M) and lower (L) canopy of an oak forest following treatment with Dipel 8AF at 6.0, 1.8 or 0.9 L/ha. Different letters within each spray block indicate significantly different means ($P<0.05$, Bonferroni).

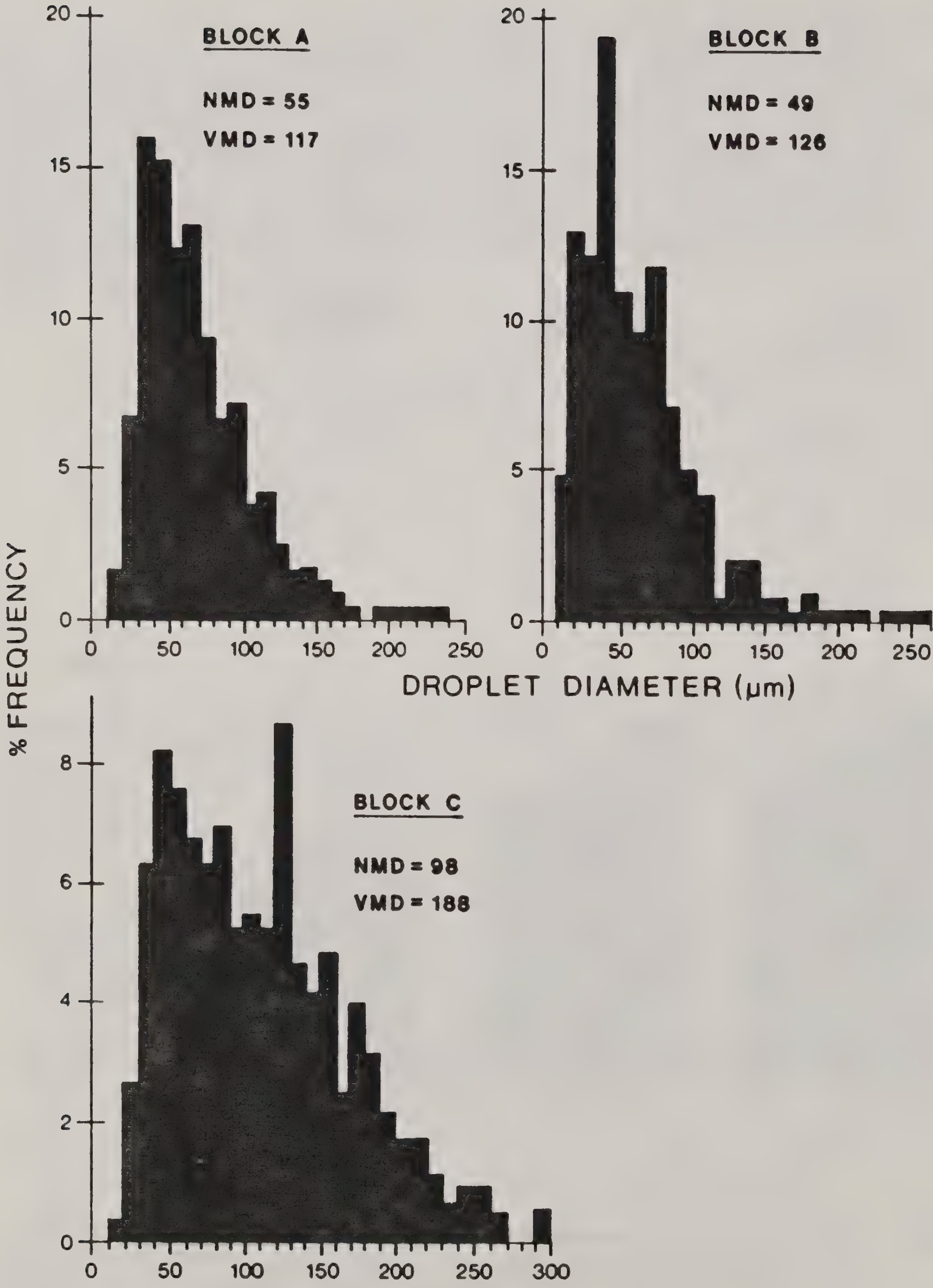

Figure 3. Frequency distribution of droplet sizes observed on foliage after application of 1.8 L/ha (block A), 0.9 L/ha (block B) or 6.0 L/ha (block C).

Table 3. Regression of % mortality of third-instar gypsy moth larvae against droplet density in the bioassays

Block	Treatment L/ha	Regression equation	R^2	P	Estimated LD_{50} (droplets/cm^2)
A	1.8	Y = 22.3 + 3.16 X	71.8	0.004	8.8
B	0.9	Y = 16.0 + 3.40 X	53.4	0.025	10.0
C	6.0	Y = 33.8 + 2.08 X	30.8	0.121	7.8
Common		Y = 18.7 + 3.55 X	0.67	0.001	8.8

Larval populations expected on the basis of the spring egg mass counts (Table 4) did not materialize because many egg masses failed to hatch. Low larval populations resulted in low defoliation in the check blocks, ranging from 15-57% with an average of 28% (Table 4). Egg mass densities in the check blocks were reduced by 25-98%, with an average reduction of 75% (Table 4). In the treated blocks, defoliation was consistently lower (12-16%) and egg mass reduction slightly greater (80-90%) than in the untreated areas, indicating that each treatment had a measurable effect. The relative effectiveness of the various treatments, however, remains equivocal because of the low population densities encountered, warranting further studies to confirm our results.

Table 4. Mean defoliation (%) and change in mean egg mass density in treated and untreated blocks

Block	Treatment L/ha	N	% Defoliation (±SE)	No. egg masses/ha (±SE) Spring	Fall	% Change
A	1.8	9	12.3 ± 0.8	3100 ± 664	455 ± 172	85
B	0.9	9	14.7 ± 0.6	1488 ± 340	266 ± 104	82
C	6.0	8	15.6 ± 0.9	2587 ± 505	250 ± 47	90
Check		6	27.8 ± 6.3	6583 ± 1288	1600 ± 698	75

This study demonstrates once again that ULV application of undiluted formulations can result in spray deposits and larval mortality equivalent to application of diluted product in higher volumes. Based on our findings, we recommend application of undiluted formulations containing 16.9 BIU/L at 30 BIU in 1.8 L/ha for operational control of gypsy moth. However, whether such low spray volumes are effective against healthy, increasing populations remains to be determined. The use of lower spray volumes also merits further investigation. Although applica-

tion of 0.9 L/ha in this study resulted in significantly lower spray deposits and less larval mortality, the use of more concentrated formulations may improve results by increasing the effectiveness of low spray deposits. In future programs we intend to assess the effectiveness of highly concentrated formulations that are already available and which can be applied at 30 BIU in 0.9 L/ha or less.

ACKNOWLEDGMENT

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REFERENCES

Cadogan, B.L.; Zylstra, B.F.; Nystrom, C.; Ebling, P.M.; Pollock, L.B. 1986. Evaluation of a new Futura formulation of *Bacillus thuringiensis* on populations of jack pine budworm, *Choristoneura pinus pinus* (Lepidoptera: Tortricidae). Proc. Ent. Soc. Ont. 117: 59-64.

Dixon, W.J. 1983. BMDP statistical software. Univ. Cal. Press, Berkeley, CA.

Fast, P.G.; Kettela, E.G.; Wiesner, C.J. 1986. Assessment of the efficacy of *Bacillus thuringiensis* against the spruce budworm. New Brunswick Spray Efficacy Research Group Report C/86/005. 37 pp.

Grimble, D.G.; Lewis, F.B. 1985. Proceedings of a Symposium: Microbial control of spruce budworms and gypsy moths. USDA-FS, GTR-NE-100, Broomall, PA.

Irland, L.C.; Rumpf, T.A. 1987. Cost trends for *Bacillus thuringiensis* in the Maine spruce budworm control program. Bull. Ent. Soc. Am. 33: 86-90.

Johnstone, D.R. 1978. Statistical description of spray drop size for controlled drop application. pp. 35-42 *in* Proceedings of a Symposium: Controlled Drop Application. British Crop Protection Council Monograph 22.

Morris, O.N. 1984. Field response of the spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae), to dosage and volume application rates of commercial *Bacillus thuringiensis*. Can. Ent. 116: 983-990.

Picot, J.J.C.; Kristmanson, D.D.; Basak-Brown, N. 1986. Canopy deposit and off-target drift in forestry aerial spraying: the effects of operational parameters. Trans. ASAE 29: 90-96.

Van Vliet, M.W.; Picot, J.J.C. 1987. Drop spectrum characterization for the Micronair AU4000 aerial spray atomizer. Atomisation and Spray Technol. 3: 123-134.

Van Frankenhuyzen, K.; Wiesner, C.J.; Riley, C.M.; Nystrom, C.W.; Robinson, A.; Sundaram, A. 1989. Distribution and efficacy of spray deposits in an oak forest canopy following aerial application of diluted and undiluted formulations of *Bacillus thuringienis* against the gypsy moth, *Lymantria dispar*. Submitted to Can. Ent.

West, R.J.; Raske, A.C.; Retnakaran, A.; Lim, K.P. 1987. Efficacy of various *Bacillus thuringiensis* Berliner var. *kurstaki* formulations and dosages in the field against the hemlock looper, *Lambdina fiscellaria fiscellaria* (Guen.) (Lepidoptera: Geometridae) in Newfoundland. Can. Ent. 119: 449-458.

Yates, W.E.; Cowden, R.E. 1986. Drop size spectra for Beecomist, Micronair, and an 8006 flat fan nozzle with Dipel 8L and Thuricide 48LV. USDA-FS FPM 86-4, Davis, CA. 25 pp.

APPENDIX A
Harold Flake

NORTH CAROLINA 1989 GYPSY MOTH TREATMENT SUMMARY

The 1989 Gypsy Moth operations in North Carolina began on Monday, March 27, 1989, with all aircraft reporting for calibration and characterization tests. This year's operation included three spray aircraft (Cessna Ag Trucks), and one observation aircraft (Cessna 180).

The 1989 spray project was the first year this many aircraft were used at one time in North Carolina. It was also the first year that undiluted Bt applications (Foray 48B) were made using Micronair AU5000 Rotary Atomizers. The dose rate for all applicationS was 20 Biu/AC with each site receiving two applications.

Aerial treatment operations began on Monday, April 17, with the first application completed by April 19. The second application was applied starting April 24, and completed on April 27.

Egg mass surveys were conducted prior to insecticide applications at site 1, 3, 4 (see attached sheet) with egg mass densities ranging from 1500-3000 EM/AC in Site 1 and 4 and 3-400 EM/AC in Site 3. Post spray Egg Mass surveys will be conducted in these areas to determine effectiveness of the applications. The attached sheets indicate the 1989 moth and larval catches and summarizes the treatment operations.

1989 GYPSY MOTH INSECTICIDE TREATMENTS
FACT SHEET

GROUND TREATMENTS

	LOCATION	NO. OF ACRES	NO. OF TRTMTS.	TOTAL TRTMT. ACRES	MATERIAL	RATE	EQUIPMENT	RECURRENCE	
1.	Henderson (Vance Co.)	2	2	4	Dimilin 25W	2 oz./Ac.	Mistblower	18 moths	
2.	Norlina (Warren Co.)	0.5	2	1	Dimilin 25W	2 oz./Ac.	Mistblower	32 moths	
3.	Greensboro (Guilford Co.)	4	2	8	Dimilin 25W	2 oz./Ac.	Mistblower	54 moths	
4.	Cashie (Bertie Co.)	6	3	18	Foray	20 BIU/Ac.	Mistblower	See aerial site	

AERIAL TREATMENTS

	LOCATION	NO. OF ACRES	NO. OF TRTMTS.	TOTAL TRTMT. ACRES	MATERIAL	RATE	EQUIPMENT	RECURRENCE	
1.	Cashie (Bertie Co.)	77	2	154	Foray	20 BIU/Ac.	Fixed Wing	638 moths	
2.	Grove Hill (Warren Co.)	42	2	84	Foray	20 BIU/Ac.	Fixed Wing	150 moths	Flat fan
3.	Old Trap (Camden Co.)	36	2	72	Foray	20 BIU/Ac.	Fixed Wing	263 moths	
4.	Winton-Ferry Ridges (Hertford-Gates Co.)	4,057	2	8,114	Foray	20 BIU/Ac.	Fixed Wing	942 moths	1/3 Flat fan
5.	Beech Swamp (Halifax Co.)	47	2	94	Foray	20 BIU/Ac.	Fixed Wing	7 moths	

TOTAL TREATMENT ACRES: Ground -- 31
Aerial -- 8,518

NORTH CAROLINA DEPARTMENT OF AGRICULTURE
GYPSY MOTH PROGRAM

1989 BURLAP BANDING SURVEY

County	Site No.	No. of Bands	Total Visits	Positive Sites	Total Larvae
Bertie	1	75	8	yes	692
	2	20	6	no	0
Brunswick	1	25	16	no	0
Camden	1	50	3	yes	1
	2	25			
Carteret	1	50	9	yes	3
Dare	1	20	2	no	0
Edgecombe	1	10	18	no	0
Gates/	1	20	5	no	0
Hertford	2	15	5	yes	85
	3	14	1	yes	139
Guilford	1	50	6	yes	35
Halifax	1	25	16	no	0
	2	25	24	yes	17
Vance	1	25	14	yes	1
Warren	1	20	14	no	0
	2	25	14	no	0

APPENDIX A
Win McLane

A Report to the National Steering Committee
for Aerial Application of Pesticides -
Gypsy Moth and Other Eastern Defoliators

Win McLane - APHIS
1989

Field plots, 50 acres in size, were treated in Pennsylvania with Dimilin using low dosages and rates of application. The material was applied to 2nd instar gypsy moth larvae with the APHIS Cessna Ag-truck aircraft. All gallon per acre applications were made with 8004 flat fan nozzle tips with lesser amounts being dispersed through 8002 tips. Dimilin 25W was used for gallon per acre treatments and Dimilin 2F (Special) for lesser amounts. Each treatment was replicated four times.

Immediately following treatment foliage was collected from one plot of the 0.03 lbs. AI/128oz/acre treatments. Some foliage was used for wash-off, fluorometer analysis and the rest of HPLC analysis. At this time analysis results are not complete.

Foray 48B, a new registered Bacillus thuringiensis product from Novo Laboratories, was also tested. The material was applied at 40 BIU/gallon/acre and at 20 BIU/gallon/acre, 2 applications, 8 days apart.

Pre-spray egg mass counts averaged 600 per acre in the treatment area. At time of treatment general foliage expansion was approximately 40 percent. There was no recordable defoliation at time of treatment.

Pre- and post-spray egg mass counts were compared, defoliation recorded and larvae under burlaps counted.

Material	Dosage/Rate	Defoliation	Ave. Larvae under Burlaps	Percent change (EM)
Dimilin 25W	.03 lbs. AI/128oz/A	0-10	1.5	-97.7
"	.015lbs. AI/128oz/A	0-10	0	-97.8
Dimilin 2F(S)	.03 lbs. AI/32 oz/A	0-10	.33	-99.6
"	.015lbs. AI/32 oz/A	0-10	0	-100
"	.03 lbs. AI/16 oz/A	0-10	.66	-99.8
Foray 48B	20BIU/128oz/A (2 app)	0-10	3.75	-98.2
"	40BIU/128oz/A	0-10	.14	-99.1
"	24BIU/64oz/A (neat)	01-0	--	-100
Control	--	20-30	6.88	-31

A cooperative Dimilin study (lower dosages and rates) was conducted in West Virginia with Richard Reardon and Uniroyal Chemical Company. Results are not complete at this time.

APHIS cooperated with Forest Service, State of Virginia and Health Chem in treating approximately 2600 acres of very lightly infested acreage with Disrupt II, the gypsy moth pheromone. No trap catches were made in the

treatment area and no tethered females were mated in the treatment area following application. However, no tethered females were mated in the untreated area outside the treatment area.

The NEFAAT group conducted charterization tests with Foray 48B at Mission, Texas during January 1989. The formulation handled well and break-up and deposit was good. We did see some build-up of material on the outside edges of the nozzle tips. This could be corrected by periodic wash-off with water.

Before calibration, Foray 48B undiluted should be circulated through the aircraft pump for approximately 10 minutes. This will allow it to reach a leveling out temperature.

We also found that the material should not be mixed with Bond sticker.

Wm McLane

W. McLane, Section Leader
Insecticide and Application Technology Section

APPENDIX A
Steve Munson
Western
Gypsy
Moth
Activities

1989 UTAH GYPSY MOTH ERADICATION PROGRAM

Steve Munson

MT. OLYMPUS COVE TREATMENT SUMMARY

AIRPORT CALIBRATION MEETING - April 26, 1989 Mark Quilter and Steve Munson met with Salt Lake International airport officials to secure a site for aircraft calibration. Airport #2 was approved by airport officials for calibration purposes.

HELIPORT SELECTION MTG. - May 2, 1989 Steve Munson and Mark Quilter met with Classic helicopter owner Brent Henderson, Larry Roe (heliport manager) and the observation pilot to review heliport selection.

AIRCRAFT CALIBRATION - On May 3, 1989 at 0600 the Bell 206-L3 was calibrated at Salt Lake City Airport #2 to determine application parameters. The following individuals assisted in the calibration of the application helicopter:

Julie Weatherby, Entomologist	USFS-Forest Pest Management
Andy Knapp, Biological Technician	USFS-Forest Pest Management
Dawn Cameron, Entomologist	USFS-Forest Pest Management
Steve Munson, Entomologist	USFS-Forest Pest Management
Mark Quilter, Agriculture Inspector	Utah Dept. of Agriculture

The results of this calibration were:

Number of nozzles - 6 Beecomist
Flying height - 50 feet above the canopy
Aircraft speed - 84 Knots, 96.2 mph
Boom pressure - 50 PSI
Flowrate - 1.22 gpm/nozzle, 14.64 gallons/minute
Droplet size - 120-150 microns
Oriface size - D6
Swath width - 100 ft.
Application rate/acre - 97.5oz
Formulation - 1 qt Bt, 2 qts. water and 1.5 oz of Plyac
Other: 120 ft. swath - 70 knots, 80.52mph

PREFLIGHT CONFERENCE - On May 9, 1989 at 0900 a preflight conference and an observation flight was conducted at the Interagency Fire Center to acquaint the application and observation pilots, aerial observer, and treatment chief with spray block boundaries, hazards within the treatment block, emergency landing sites and heliport operations site. During the preflight conference the heliport manager briefed the pilots on safety procedures at the heliport site and the aerial observer described the application program's communication plan. Representatives from the Salt Lake County Sheriff's Department and the Federal Aviation Administration were also present to discuss safety and emergency procedures.

OPERATIONS CONFERENCE - The treatment chief briefed the load checker and field personnel on their responsibilites for the project on May 10, 1989. During this conference card sites, balloon corners, weather information, product mixing and sampling procedures were discussed.

FIRST APPLICATION - The first application was conducted May 11th at 0600. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind <10 mph, Wind Direction - East, RH - 55-82%. Conditions from 0900 to 1000: Wind <10 mph, Wind Direction - East, RH - 56-73%. An intermittent light rain fell at the heliport for 10 minutes during the final application. At 1500 hours within the Mt Olympus Cove area thundershowers developed and 1.8 inches of rain fell over a 2 hour period. Intense periods of hail accompanied the thunderstorm. Approximately 5 hours of drying time had elapsed prior to the rainfall.

Airport Operations - The first application began at 0602 MST with 80 gallons of formulation in the first load. Upon return, the pilot felt he could safely carry 100 gallons of material with each load. Flight time for application ranged between 11-15 minutes/load. Average loading time was 3-4 minutes. The heliport site was kept moist to reduce the amount of flying debris as the helicopters landed and took-off. On the 3rd load some problems developed with mixing because the Bt drums weren't properly agitated before pumping. The pump filter became clogged and had to be removed and cleaned. All mixing was done at the time of application. After talking with Frank Hewlitt from Abbott Labs it was determined that the tank mixes could be completed the day before treatment. A total of 980 gallons of formulation was applied in the first application (647.4 gallons of water, 323.7 gallons of Bt, and 8.9 gallons of Playac). Ten loads of material were applied, 5 loads before 0730 and 5 loads after 0900. The first application was completed at 1003 MST. Approximately 3 gallons of Bt was spilled at the loading site when a hose backflushed from the drum. The material was cleaned up using kitty litter and the area was flushed with water.

Field Operations - A total of 78 spray deposit cards were placed at specified locations within the treatment block. Of these, 2 cards were not recovered, 3 cards were saturated by lawn sprinklers, 4 cards had light deposit and the remaining 69 cards had good spray deposit. Of the 4 cards with light deposit, 2 were directly under an oak canopy which would account for the light deposition. Card numbers 32 (Thousand Oaks Circle) and 35 (East Cliff Circle) may have had very light coverage of the Bt material during the first treatment.
The individuals who placed balloons and took the weather data had an abundance of free time during the first application. During applications 2 and 3 their responsibilities were combined with the card placement crews. As a result, the field staff was able to radio information to the treatment chief at a faster rate ensuring more thorough coverage of the spray area and reducing treatment skips.

Insect development - Instar development was recorded at 3 permanent plot sites: #2 (Zarahemla Dr), #4 (Gilead Way) and #10 (Mathews Way). On May 11th, 82.3% were in the first instar and 17.6% were second instar larvae.

SECOND APPLICATION - The second application began on May 18th at 0557. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind speed were <10 mph with the exception of Parleys Canyon where wind gusts up to 16 mph were recorded. Wind direction was from the east in the majority of the treatment block and RH ranged from 28-70 percent. The lowest RH percentages were recorded in Neff's Canyon. Conditions from 0900 to 1000: Wind speed <10 mph, wind gusts in Parley's Canyon had subsided to <10 mph. Wind direction remained from the east and RH had dropped to 35-42 percent. The lower RH percentages were recorded in the mouth of Millcreek and Parley's Canyons.

Airport Operations - The first application began at 0557 MST with 100 gallons in the first load. The amount of material loaded varied between 94 and 110 gallons. The material had been premixed at 1400 hours on May 17th. Average loading time was 1.5 to 4 minutes. Flight time per application averaged 12-15 minutes. A total of 1004 gallons of formulation was applied during the second treatment (660 gallons of water, 330 gallons of Bt, and 15 gallons of Plyac = 1005 gallons of mixed formulation). Ten loads of material were applied, 6 loads before 0730 and 4 loads after 0900. The second application was completed at 0951 MST. No spills were recorded during the loading or the mixing operations.
Field operations - Seventy-seven spray deposit cards were placed at specified card locations within the treatment block. All the deposit cards were recovered, 6 of the recovered cards had light deposit. Card numbers 5 (Parkview Drive), 6 (Mt. Olympus Way), 22 (Zarahemla Drive), 58 (near balloon location #2) and M1 (mouth of Millcreek Canyon) had light coverage on the cards during the 2nd application. As a result of the spray deposit card information, most if not all of these areas were retreated to ensure adequate spray coverage within the treatment block. A skip did occur in the 2nd treatment on Parkview Drive between card locations 3 and 4. This area was marked on the map to ensure adequate spray coverage during the 3rd application.

Insect development - Instar development was recorded at the same 3 permanent plot sites indicated under the first application. On May 19th, 64% were in the first instar, 35.5% were second instar, and 0.5% were in the third instar. Timed larval counts were made at each of the 3 plot locations, an average of 7.76 larvae were counted/minute.

THIRD APPLICATION - The third application was conducted May 25th at 0555. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind <10 mph with an occasional gust in Millcreek Canyon to 12 mph. Wind direction was from the east and RH ranged from 45-78 percent. Conditions from 0900 to 1000: Wind speeds decreased to <5 mph. Wind direction continued from the east, RH dropped

to 25-48 percent. A low RH reading (25 percent) was recorded in Neff's Canyon, all others remained above 30 percent.

Airport Operations - The first application began at 0555 MST. Flight time averaged 10-16 minutes and the average loading time was 1.5-3 minutes. Between loads 12 and 13, 24 minutes elapsed due to mixing of additional material. A total of 1293 gallons of formulation was applied during the 3rd application (850 gallons of water, 427 gallons of Bt and 17.5 gallons of Plyac = 1,294.5 gallons of mix). The remaining 1.5 gallons was added to the rinse and deposited within the treatment block boundary. Thirteen loads of material were applied ranging from 84-109 gallons. Six loads were applied between 0600 and 0730 and 7 loads after 0900. Additional material was sprayed during the third application over areas with high populations and on the border areas on National Forest land to ensure complete and effective coverage of the treatment block. The application helicopter returned to the heliport area at 1107 MST completing the aerial phase of the Gypsy Moth eradication program in the Mt. Olympus area.

Field Operations - Eighty-one spray deposit cards were placed within the treatment area during the third application. Of these, 4 cards were missing and not retrieved and 2 cards had light deposition - card numbers 49 (Crestview Drive) and 34 (Thousand Oaks Drive). Both areas were retreated, however the cards were not in place during the retreatment. The area missed on Parkview Drive during the second application was treated twice to ensure full coverage of the skipped area.

Insect development - Instar development recorded at the 3 permanent plot sites on May 25 indicated 56.1% were in the first instar and 43.9% were second instar larvae. Larvae counts taken at these same locations averaged 2.38 larvae/minute. Based on the larval counts made on May 19th, a 70% reduction in larval numbers had occurred following the second treatment.

Post-Treatment Conferences - A conference was held among project personnel following the first and second applications. Items discussed included: project operations, instar development, timing of the next application, product performance and project safety.

Treatment Effectiveness - Ten 1/40th acre plots were established in the treatment block to monitor egg mass numbers. Plots were marked using orange ribbon and metal tags. Pre-treatment egg mass numbers were recorded at each plot. At the end of September, the plots were revisited and egg masses counted. Overall egg mass reduction within the treatment block was tabulated. The following data collected on April 20, 1989 lists plot number, location, host type and egg mass counts:

PLOT #	LOCATION	HOST TYPE	EGG MASSES/ACRE
1	Abinadi Road	90% Oak, 10% Maple	160
2	Zarahemla Way	70% Oak, 30% Maple	640
3	Zarahemla Way	60% Oak, 40% Maple	0
4	Gilead Way	95% Oak, 5% Maple	1,280
5	Neffs Canyon	40% Oak, 60% Maple	0

6	Neffs Canyon	90% Oak, 10% Maple	0
7	Boy Scout Camp	10% Oak, 90% Maple	0
8	Mill Creek Canyon	90% Oak, 10% Maple	80
9	Cove Crest	95% Oak, 5% Maple	0
10	Mathews Way	100% Oak, 0% Maple	4,240

The following data was collected on September 29, 1989:

PLOT #	EGG MASSES/ACRE
1	0
2	0
3	0
4	80
5	0
6	0
7	0
8	0
9	0
10	40

Summary - On June 5, 1989 final larval counts were made at the 3 permanent plot sites. An average of 0.35 larvae/minute were counted, which indicates a 95% reduction in larval numbers compared to the original counts conducted on May 19th. The results of the egg mass survey indicate a 98% egg mass reduction within the 10 plots surveyed. However, a skip was noted covering 2.5 acres within the treatment block and egg mass numbers within this area average 200/acre.
No major spills or accidents occurred during any of the 3 applications. Based on current data, the aerial treatment project with Bt can be considered a successful spray operation. A total of 3,600 acres (3,300 private and 300 federal) were treated in the 1989 Gypsy Moth Eradication Program. Project personnel are to be commended for a safe and efficient aerial treatment program.

STATE OF IDAHO

1989 GYPSY MOTH REPORT

prepared by

R. LADD LIVINGSTON

SUPERVISOR, INSECT AND DISEASE SECTION

IDAHO DEPARTMENT OF LANDS

October 30, 1989

In 1989, we conducted gypsy moth projects for both eradication and detection.

ERADICATION

We used both aerial applications of Bt and follow-up mass trapping in our eradication efforts in 1989. We aerially treated 380 acres (110 acres in Coeur d'Alene and 270 acres in Sandpoint) and mass-trapped 817 acres (150 in Coeur d'Alene and 607 in Sandpoint). In the detection survey, combined with the mass trapping, we caught 32 moths in Coeur d'Alene and 29 in Sandpoint. This represents reductions of 67 and 93 percent, respectively, compared to 1988 catches. Egg mass surveys found 4 new egg masses in Coeur d'Alene and 5 in Sandpoint.

The aerial treatment was done with a Hiller 12E Soloy. We used 6 electronic rotary atomizer Beecomist nozzles to deliver 96 oz/ac. Our spray was Abbott's Dipel 8L; 1 quart of pesticide in 2 quarts of water with 2 percent by volume of Plyac sticker.

Mass trapping was done at 9 traps per acre. We checked the traps twice per week through the peak flight period and replaced traps when moths were found.

Project costs were $123.87 per acre for the spraying and $57.78 per acre for the mass trapping with a total project cost of $191.65 per acre.

DETECTION

All major cities and towns in Idaho were surveyed with detection traps at 4 per acre in 1989. We also had traps at many campgrounds and tourist attraction sites. A total of 2,248 detection traps were placed. The effort is a cooperative one with participation by the Idaho Departments of Lands and Agriculture and the USDA-Forest Service Regions 4 and 1. The detection effort trapped 6 moths in an area west of Sandpoint approximately 1.5 miles outside of the treatment zone; 7 moths in Idaho Falls, Idaho, and 1 moth in Pocatello. These last two cities represent new areas. We will conduct delimiting surveys in these new areas next year.

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF FOOD AND AGRICULTURE

1220 N Street
Sacramento, California 95814

October 26, 1989

Mr. Steve Munson
Forest Pest Management
U.S. Forest Service
324-25th Street
Ogden, Utah 84401

Dear Mr. Munson:

The California Department of Food and Agriculture maintains a statewide detection program for gypsy moth using trap densities of two traps per square mile in most residential and densely populated rural areas, and three traps per square mile in rapidly growing coastal areas. High risk sites such as campgrounds, recreational areas, mobile home parks, etc., are trapped at a minimum of one trap per site. Upon catching an adult gypsy moth, trap density is increased to 25 traps per square mile in a four-square-mile area around the find. During 1989 this detection and delimitation system caught 33 gypsy moths in 12 counties spread from San Diego to Cottonwood near Mt. Shasta (see attachment). As of August 31, 1989, there were approximately 21,000 gypsy moth traps in place.

In addition, most incoming moving vans from gypsy moth infested areas of the East have their contents inspected upon arrival. If there are any signs of gypsy moth eggs, larvae, or pupae, 25 traps are deployed in a square-mile area around the move-in site. The quarantine traps caught 23 gypsy moths in 1989 in three counties with the majority (15) coming from the City of Tiburon in Marin County.

In total, 56 adult gypsy moths were captured in 14 counties, with the greatest number coming from Marin County (25) and San Diego County (8). Egg mass surveys, conducted around all multiple trap catches, found egg masses at single sites in Marin and Placer Counties. A limited treatment program using either Dimilin or Bt from the ground is being planned for these locations in 1990. The source of infestation for both sites has been specifically

identified to residents arriving in 1988 from high hazard areas in the Northeastern U.S. It is possible that the La Mesa site in San Diego County may be treated in 1990, pending further egg mass surveys.

Trap densities of 25 traps per square mile over a four-square-mile area will be maintained around all single moth capture sites for 1990.

Sincerely,

John Connell

John Connell
Program Supervisor
Pest Detection/Emergency Projects
Division of Plant Industry
(916) 324-3761

Attachment

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
Pest Detection/Emergency Projects

SUMMARY - 1989 GYPSY MOTH FINDS

COUNTY	<--ADULTS TRAPPED--> DETECTION	QUARANTINE	TOTAL ADULTS	PROPERTIES WITH VIABLE EGG MASSES/ PUPAL CASES
ALAMEDA	2	0	2	0
Berkeley (2)				
LOS ANGELES	4	0	4	0
Chatsworth (1)				
Newhall (1)				
Sun Valley (1)				
Woodland Hills (1)				
MARIN	6	19	25	1
Fairfax (2,0,0)				
Novato (0,1,0)				
San Anselmo (2,0,0)				
San Rafael (0,3,0)				
Tiburon (2,15,1)				
NEVADA	3	0	3	0
Grass Valley (3)				
ORANGE				
Anaheim (1)	2	0	2	0
Fullerton (1)				
PLACER	0	3	3	1
Roseville (0,3,1)				
SACRAMENTO	1	0	1	0
Carmichael (1)				
SAN DIEGO	8	0	8	0
La Mesa (7)				
Valley Center (1)				
SAN JOAQUIN	1	0	1	0
Manteca (1)				
SAN MATEO	1	0	1	0
Menlo Park (1)				
SANTA CLARA	0	1	1	0
San Jose (1)				
SHASTA	2	0	2	0
Cottonwood (2)				

TUOLUMNE Sonora (1)	1	0	1	0
VENTURA Thousand Oaks (2)	2	0	2	0
	33	23	56	2

9-6-89

Colorado State Forest Service
Colorado State University
Fort Collins, CO 80523

October 26, 1989

Steve Munson
USDA - Forest Service
Forest Pest Management
325 25th Street
Ogden, Utah 84401

Dear Steve,

Here is a real hasty and rough summary of our gypsy moth program for you to use with your report back East.

KNOWN CITIES WITH SOME LEVEL OF GYPSY MOTH INFESTATION PRIOR TO SUMMER 1989

Boulder (first found in 1985 via detection trapping)

Fort Collins (first found in 1985 via detection trapping)
"East" infestation
"West" infestation

Lakewood (first found in 1987 via detection trapping)

All three of these received detection (1/square mile), delimitation (25/square mile), and mass (9/acre) trapping. Areas represented by (+) catches in previous years were mass-trapped. Delimitation "doughnuts" of ¼ mile were placed around the mass-trapped areas. Detection trapping was installed for the rest of the respective city areas.

All cities and towns in the state were trapped, plus potential problem spots. Total traps installed in Colorado during 1989: approximately 3900.

Six properties in Boulder were sprayed from the ground with *Bacillus thuringiensis* (Dipel 4L) at a rate equivalent to 16 BIU's/acre, three times in May.

Five properties in Fort Collins ("West" infestation area) were sprayed according to the same scheme.

1989 RESULTS

Boulder: 0 male catches for 1989 following aerial applications of Bt in 1988 and small-scale ground applications this year. This infestation is tentatively considered eradicated. Probably limited mass-trapping will be employed next year as a precaution.

Fort Collins ("East"): 5 males (1 moth in each of 5 traps). This area treated with induced inherited sterility (="F1") technique in 1988, mass-trapping only in 1989. Tentative plans are to spray 3-4 block area with Bt from the ground in 1990.

Fort Collins ("West"): 0 male catches for 1989, following large-scale ground spraying in 1988 and small-scale ground spraying (both with Bt) in 1989. This infestation is conditionally viewed as eradicated. Limited trapping is planned for 1990 as a precaution.

Fort Collins (general): 2 outlying catches in 1989 at locations widely separate from known infestations. These specific sites will be mass-trapped in 1990 to determine if they are new introductions or stray moths tied to the two known problem spots.

Lakewood: 0 male catches in 1989. This area was mass-trapped in both 1988 and 1989, but no spraying took place (that we know of). The 0 catch is a mystery, unless landowners undertook treatments on their own that took care of the population via spraying or host removal. Plans are to mass-trap again in 1990. (FYI, the high annual male catch in this area was 43 moths in 1988).

NEW LOCATIONS DISCOVERED VIA DETECTION TRAPS IN 1989:

Limon: 1 moth

Colorado Springs: 1 moth (1 moth was trapped here in 1987 in almost the same location. Trapping in 1988 was negative. Extended diapause?)

NEW LOCATION DISCOVERED VIA CITIZEN INPUT IN 1989:

Westcliff: 10 egg masses and 1 live female confiscated from "outdoor household articles" brought into CO from New Jersey. Landowner alerted us to this situation. This area will be monitored with traps in 1990.

In summary we feel we are very close to eradication in our three cities with established gypsy moth infestations. We feel both aerial and ground applications of Bt can be effective, particularly when increasingly-dense trapping is used to focus the treatment area. Mass-trapping is at least a partial control technique. Every effort to obtain and incorporate citizen input regarding trapping and control operations is worth the effort. Detection trapping is a very effective way to discover new infestations.

Dave Leatherman DAL
Entomologist
(303) 491-6303

APPENDIX A
Michelle Frank

PRELIMINARY REPORT

VERMONT PEAR THRIPS PILOT STUDY

MAY 17, 1989

Introduction

The Vermont Pear Thrips Pilot Study tested the effectiveness of Sevin Brand 4 Oil in reducing pear thrips populations and preventing sugar maple leaf injury. Two timings were tested. The first timing, at first emergence of thrips from the soil, was completed on April 26. The second spray timing, at peak emergence of thrips from the soil, was completed on May 4. Spray plane calibrations were accomplished in Fryeburg, Maine from April 20 to 22, to obtain a V.M.D. of 270 and 30 drops per square centimeter.

Application Specifications

All aerial spraying was done using a Grumman AgCat fixed wing airplane operated by Les Hill from Fryeburg, Maine. Twenty-two flat fan nozzles (8004) were placed on the spray boom to obtain an application rate of 9.77 gallons per minute under 40 lbs of pressure. Spray mix contained Sevin Brand 4 Oil mixed with deoderized kerosene and two dyes: Rhodamine Red WT and Key Tect Tracer Yellow R. The red dye faciliated use of the swath kit spray card analizer and the yellow dye was added to make it possible to count spray droplets on sugar maple twigs using an ultra violet light. One pound per acre active ingredient was used with a spray mix of 32 oz. of Sevin Brand 4 Oil and 32 oz. of kerosene for a total of 64 oz. per acre. The dye was added at 1% red dye and 0.1% yellow dye.

The spray plane operated at 100 mph and acheived a 100 foot swath width. During the first and second spray applications, 137 and 263 acres were sprayed, respectively, to total 400 acres sprayed.

A monitor plane was used during spray application to facilitate plot location and to record application information. Radio communication was maintained between the monitor plane and the spray plane, and between ground crews and the monitor plane. Two meteorological stations were established on each spray day, to monitor weather conditions throughout the spray operation. Local wind information was also monitored using hand held animometers and smoke bombs.

Evaluation

Prior to plot set-up, soil samples were taken in all plots to determine pear thrips population levels. Plots with an average of seven thrips per bulb planters worth of soil were selected as spray or check plots. Plot boundaries were marked, and 10 sample trees were lelected in a line running diagonally from opposite corners of the plot. Ten emergence traps were placed in each plot to monitor thrips emergence from the soil on a daily basis.

Tree climbers were used to take twig sample from each of 10 sample trees per study plot. A total of 360 - 4 cm. twig samples (including apical bud(s)) per plot were taken prior to each spray application to establish numbers of thrips per bud in spray and check plots. Five spray plots and 4 check plots were used for each spray timing for a total of 18 treatment plots. Sampling was repeated approximately 3 days post-spray. These bud samples are currently being processed to determine spray effectiveness in reducing pear thrips populations.

In addition, equal number of twig samples were taken for counts of spray droplets at three heights of the canopy. These will be processed to count numbers of droplets on and near buds.

In early June, climbers will be used to clip additional branches for use in evaluating leaf size, leaf injury, and oviposition sites. All 18 plots will be sampled and twigs processed. This information will be complemented by ground and aerial damage assessment to be done in early June.

New England & New York Insect Conditions 1989

Eastern Spruce Budworm

Spruce budworm defoliated acreage has continued to be low with 5,000 acres in Maine. No defolition was reported in other states. Pheromone trapping confirm low population levels. This trend is expected to continue in 1990.

No suppression projects were undertaken in 1989, with none planned in 1990.

Defoliation by Spruce Budworm
in 1988 and 1989

Region/State	Area Defoliated 1988 (Ac)	Area Defoliated 1989 (Ac)
Northeast		
New Hampshire	0	0
New York	0	0
Maine	64,951	5,000
Vermont	0	0

Gypsy Moth

Gypsy moth defoliation increased throughout New England and New York except for Rhode Island. There was a total of 555,287 acres defoliated in 1989 compared to 19,882 acres in 1987. No control projects were undertaken in 1989, however there are requested for funding to spray 38,200 acres in 1990 (Table A, below).

A fungi, Entomophaga, killed large numbers of gypsy moth larvae in many areas throughout New England and New York. In some cases entire populations were dramatically reduced. We don't know the long-range impact on this gypsy moth outbreak.

Dan, Morgantown has all the G.M. maps digitized in their GIS.

Defoliation by Gypsy Moth
in 1988 and 1989

Region/State	Area Defoliated 1988 (Ac)	Area Defoliated 1989 (Ac)
Northeast		
New Hampshire	1,015	18,400
New York	15,700	421,138
Maine	100	15,000
Vermont	703	21,377
Massachusetts	0	950
Connecticut	1,639	78,430
Rhode Island	725	0

Table A.

Cooperative State and Federal Gypsy Moth
Suppression Projects - 1990

State or Federal Site	B.t.	
Vermont	6,000	
Massachusetts	25,000	
	500	Foci Project
Green Mountain NF, VT	3,700	
White Mountain NF, NH	3,000	
Total	38,200	

Forest Tent Caterpillar

The forest tent caterpillar was reported in New York where about 1,500 acres were visibly defoliated in 1989.

Hemlock Woolly Adelgid

The hemlock woolly adelgid was reported in NY, CT, RI, and MA in 1989. Massachusetts is the most recent state to confirm the adelgid's presence. It was first reported on two backyard trees this spring, and then the adelgid was confirmed nearby in a city park where several dozen trees are infested. The adelgid has also spread to new sites in CT and NY, bringing the total acreage infested to 2,500 and 4,000 acres respectively.

There were no control projects in 1989. Both Massachusetts and Rhode Island are considering ground applications in 1990 to eradicate their newly established infestations.

Pear Thrips

The pear thrips damaged far less acreage in 1989 compared to 1988. For example, Vermont reported less than 10,000 acres damaged in 1989 compared to about 450,000 acres in 1988. New Hampshire and Massachusetts reported similar damage reductions. These 3 states were the hardest hit in 1988. Vermont noted that this sharp damage reduction was not accompanied by a collapse of the pear thrips population. Thrips were abundant in 1989, they simply did not cause the damage observed in 1988. The difference is thought to be the result of different synchrony between host and insects.

The Vermont Department of Forest, Parks and Recreation in cooperation with the USDA Forest Service carried out a pilot control project against pear thrips in 1989. Sevin 4 Oil was applied by an AgCat on 400 acres (137 acres treated early and 263 acres treated later). The treatment evaluation is continuing although the lower than expected 1989 damage will complicate the analysis.

PEAR THRIPS DAMAGE IN VERMONT
Summary of Aerial Survey Results for 1989

County	ACRES DAMAGED IN EACH CATEGORY Light	Moderate	Heavy	Total
ADDISON		400		400
BENNINGTON				0
CALEDONIA	150			150
CHITTENDEN		870		870
ESSEX				0
FRANKLIN		135		135
GRAND ISLE				0
LAMOILLE		244	440	684
ORANGE				0
ORLEANS				0
RUTLAND				0
WASHINGTON		935		935
WINDHAM				0
WINDSOR				0
TOTAL	150	2584	440	3174

APPENDIX A
Barry Towers

ISI,
You can use this
&
Barry
Towers

Appendix A-5

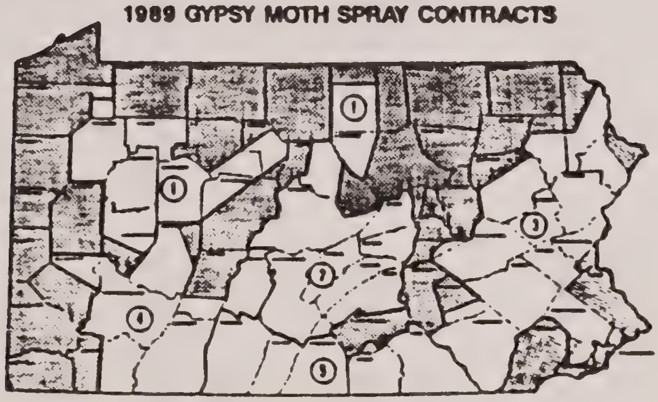
Pennsylvania Bureau of Forestry
1989 Gypsy Moth Suppression Project
A Summary

Acres Treated by Ownership and Insecticide

Ownership	Bt		Dimilin		Total	
	Acres	Blocks	Acres	Blocks	Acres	Blocks
Private	83,684	1,326	1,180	6	84,864	1,332
State Forest	885	9	90,013	170	90,898	179
State Parks	7,943	10	10,758	40	18,701	50
Federal	170	6	-	-	170	6
Other	20	1	1,113	7	1,133	8
Totals	92,702	1,352	103,064	223	195,766	1,575

Contract Areas

1989 GYPSY MOTH SPRAY CONTRACTS



Spray Aircraft Used

Contract 89-1
- 3 - Bell 204
- 1 - Bell 206
- 2 - Hughes 500D

Contract 89-2
- 1 - Bell 204
- 3 - Bell 206

Contract 89-3
- 1 - Bell 206
- 1 - Bell Soloy
- 3 - Sikorsky S55

Contract 89-4
- 1 - Bell 204
- 1 - Bell 206
- 1 - Bell 47G

Contract 89-5
- 1 - Bell 204
- 1 - Bell 47G
- 2 - Bell Soloy

Miscellaneous

Start Date: May 9, 1989 Finish Date: June 7, 1989

Insecticides: Bt-Dipel 8AF, 16 BIU, 1 gallon/acre (24,761 acres)
Bt-Dipel 8AF, 20 BIU, 40 ounces/acre undiluted (1,032 acres)
Bt- Dipel 8L, 16 BIU, 1 gallon/acre (66,909 acres)
Diflubenzuron-Dimilin 25W, .25 ounce AI, one gallon/acre (103,064 acres)

Contract Costs - 1989 Gypsy Moth Suppression Project

Contractor	Contract	Bid Price		Acres Treated		Gallons Applied		Actual Cost/Acre		Contract Cost		
		Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Total
AgRotors, Inc. Gettysburg, Pa.	89-1	$13.97	$11.56	14,271	28,923	14,501	28,923	$14.20	$11.56	$ 202,578.97	$ 334,349.88	$ 536,928.85
AgRotors, Inc.	89-2	13.62	11.21	5,504	41,389	5,504	41,396	13.62	11.21	74,964.48	464,049.16	539,013.64
Cordoba Helicopter Enterprises, Inc.* Hightstown, N. J.	89-3	14.70	11.98	46,229	923	46,046	923	14.90	11.98	688,636.20	11,057.54	699,693.74
AgRotors, Inc.**	89-4	15.35	12.81	11,522	4,454	12,403	4,454	16.52	12.81	190,386.05	57,055.74	247,441.79
Helicopter Applicators, Inc. Frederick, Md.	89-5	15.23	8.53	15,176	25,495	16,690	25,495	16.75	8.53	254,108.70	217,472.35	471,661.05
Option II	-	-	9.00	-	1,880	-	1,880	-	9.00	-	16,920.00	16,920.00
All		$14.69	$10.78	92,702	103,064	95,944	103,071	$15.22	$10.68	$1,410,754.40	$1,100,904.67	$2,511,659.07

Subcontractors:

*Cane Air, Inc., Belle Rose, Louisiana

*Teryjon Aviation, St. Peter, Minnesota

**Helicopter Systems, Inc., Scottdale, Pennsylvania

APPENDIX B

OPERATING GUIDELINES
FOR
NATIONAL STEERING COMMITTEES
CONSIDERING
FIELD TESTS AND PILOT PROJECTS
FOR THE
AERIAL APPLICATION OF PESTICIDES

MEMBERSHIP: Committees members should be nationally recognized research, developmental, and applied scientists as well as natural resource professionals drawn for the most part from the Forest Service but also from other Federal and State agencies.

PURPOSE: The committees' primary tasks are to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperators ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

PROCEDURES:

The committees shall:

- meet at least annually, preferably during late summer or early fall so recommended projects can be considered for approval, funding, and implementation the next field season.

- focus on sound science that may lead to improving pesticide application consistent with its stated purpose.

- assign priorities to testing needs agreed to by the committee.

- review data and progress of field and pilot tests.

- suggest who might conduct future tests and where the tests might be conducted.

- take action to address needs such as development of guidelines for field test and pilot projects, database formats, and literature studies.

- establish sub-committees to pursue single issues such as review of laboratory and field test data.

The members shall:

- determine pesticide application needs within their geographical, administrative or organizational area prior to each meeting.

- be cognizant of all appropriate Region/Area/Station/State/cooperator needs.

- bring to the meeting needs that have been discussed with line officers and staff.

- represent the unit's needs within the national perspective of the committee.

The Director FPM/WO shall:

- coordinate the report recommendations within WO, and with the Regions, NA, and Stations as appropriate.

- review the steering committee recommendations and resultant FPM project proposals for funding.

- give strong consideration to the steering committees recommendations in prioritizing project proposals for funding.

- complete project approval and funding by January for projects funded by FPM.

APPENDIX C
Dennis Hamel

United States Department of Agriculture | Forest Service | WO

Reply to: 2150 **Date:** October 13, 1989

Subject: Trip Report to GM/Bt Meeting

To: Max Ollieu

On October 11-12 I attended the gypsy moth (GM)/Bacillus thuringiensis (Bt) meeting in Middletown, Pennsylvania. The meeting was sponsored by an ad hoc committee of State and Federal government personnel and industry and user-community representatives. A copy of the agenda and list of members is enclosed. The meeting was quite productive with good discussion on a wide variety of subjects related to GM and Bt.

One purpose of the meeting is to review the past season's activities and identify needed laboratory and field research for the next season. Listed on the enclosed sheet are the unprioritized list of items discussed. In addition, Enclosures 3-5, identify the recommended research efforts said to be needed by Abbott, NoVo, and Ecogen respectively.

Norm DuBois will prepare a set of minutes from the meeting. At that time these research needs will be prioritized (based on a blind vote of the membership) and recommendations will be made to the FS Eastern Defoliator Steering Committee and others.

At the meeting I was asked to discuss several issues pertaining to FS policy and direction on field experiments, pilot projects, and good laboratory practices (GLP).

The committee was aware of FS efforts to develop guidelines for the conduct of field experiments and pilot projects and they are very supportive of them. Considerable discussion took place on the subject of qualifications of aircraft pilots; however, it was finally decided that this subject was better left to contracting and not be a part of the present guidelines. I concurred and will send recommended language to Jack Barry who can coordinate with Pat Shea.

On the subject of GLPs it was also recommended that the FS and others expedite the preparation and dissemination of guidelines for compliance with 40 CFR 160 (FIFRA) and 40 CFR 792 (TSCA). The Agricultural Research Service (ARS) is ahead of the FS in this regard and Raph Webb offered an example of what ARS scientists are required to do on a daily basis. The FS needs to follow up with Charles "Deacon" Smith and Paul Schwartz (344-3256) on this subject.

In summary, this was a good meeting. It provided a forum for open discussion and the WO should attempt to continue its involvement with the group in the future.

/s/ DENNIS R. HAMEL

DENNIS R. HAMEL
Pesticide Specialist

Enclosures (9)
Agenda
Research Needs
Abbott Research Priorities
NoVo Research Priorities
Ecogen Research Priorities
Guidelines for Field Experiments
Guidelines for Pilot Projects
ARS GLPs
General Information

cc: without enclosures
J. Barry
T. Hofacker
J. Space
N. DuBois

Enclosure 2

Identified Research Needs

Laboratory

-Lab screening of new formulations

-Effects of Bt with and without stickers on car paint finishes.

-Bt drying time and rain fastness.

-Feeding stimulants/inhibitors.

-Toxic dose based on droplet density/ droplet size.

-Temperature effects on Bt.

-Exposure time vs Bt effectiveness.

-Protein toxicity.

-Salt air/acid rain effects on Bt.

-Bt degradation factors.

-GM bioassay test--standard unit.

Field

-Undiluted applications using Micronairs, Beecomist, Flat Fan atomizers to get small droplets of uniform size.

-Comparison of effectiveness of mist blower vs hydraulic sprayer for ground applns.

-1 vs 2 applications of Bt based on egg mass densities.

-High dose Bt vs diflubenzuron on GM populations reduction.

-High dose Bt on building (healthy) populations.

-Field test Mycogen MYX 8242.

-Navigations systems.

-Effect of poor application techniques.

-Bt residual effects.

-Bt effects on non targets.

-High potency formulations.

SECTION 2

SECOND ANNUAL REPORT

National Steering Committee for
Aerial Application of Pesticides -
Seed and Cone Insects

April 18, 1990

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

I. INTRODUCTION

The second annual meeting of this committee met in Salt Lake City, UT, on November 8-9, 1989.

A. Committee Members

Larry Barber	R-8/FPM (Asheville, NC)
Scott Cameron	TX Forest Service (Lufkin, TX)
Gary DeBarr	SE/FIDR (Athens, GA)
Jed Dewey	R-1/FPM (Missoula, MT)
Wayne Dixon	FL Division of Forestry (Gainesville, GA)
Peter deGroot	FPMI (Sault St. Marie, Ontario)
Kees van Frankenhuyzen	FPMI (Sault St. Marie, Ontario)
Mike Haverty	PSW/FIDR (Berkeley, CA)
Tom Hofacker	WO/FPM (Washington, DC)
Dave Overhulser	Oregon Department of Forestry (Salem, OR)
Charles Masters	Weyerhaueser Co. (Centralia, WA)
Chris Niwa	PNW/FIDR (Corvallis, OR)
Max Ollieu	WO/FPM (Washington, DC)
Roger Sandquist	R-6/FPM (Portland, OR)
John Taylor	R-8/FPM (Atlanta, GA)
Jack Barry (Chair)	WO/FPM (Davis, CA)

Four other members, Peter deGroot and Kees van Frankenhuyzen (FPMI); and Tom Hofacker and Max Ollieu (WO-FPM) were not able to attend. Since the meeting Tim Schowalter, entomologist, Oregon State University has accepted our invitation to join this committee.

B. Purpose of Committee

The purpose of the committee is to review, identify, and recommend needs for field tests, pilot projects, and demonstrations of application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that

influence the FS's and State cooperator's ability to use pesticides safely, effectively, and in an economically and environmentally acceptable manner.

C. Operating Guidelines

Operating guidelines generic to the four FPM national steering committees are enclosed (Appendix A). The committee also recommends an additional guideline as stated in paragraph III., H., 1., "scope of this committee shall include all methods of managing seed and cone insects."

II. RECOMMENDATIONS

Recommendations are ranked by priority with 1 being the highest priority. Committee's recommendation of who should take the lead also is included with each recommendation.

A. Laboratory/Field Studies

1. **Develop methods to monitor major seed and cone insects, and to predict population levels and treatment timing.**

High Priority (1) - M. Haverty
C. Niwa

2. **Study and establish relationship of pest levels to subsequent damage by major seed and cone insects.**

High Priority (2) - M. Haverty
C. Niwa

3. **Develop toxicity data for seed bug and establish lower thresholds.**

High Priority (3) - G. DeBarr

B. Field Tests

1. **Conduct field tests of pyrethroids in Douglas-fir orchards:**

a. **Evaluate pyrethroids as alternatives to systemic insecticides for control of gall midge.**

High Priority (1) - M. Haverty

b. **Evaluate other pyrethroids as alternatives to Asana for control of cone worm and chalcid.**

High Priority (1) - M. Haverty

2. **Conduct field tests of undiluted B.t. to control target species of Dioryctria in eastern and western seed orchards.**

Low Priority - M. Haverty
G. DeBarr

C. Demonstrations

1. **Demonstrate utility of FSCBG aerial spray model to plan an aerial spray project in a western and eastern seed orchard.**

High Priority (1) - J. Barry

2. **Demonstrate understory burning strategy to control white pine cone beetle in Ohio, Pennsylvania, and North Carolina white pine seed orchards.**

High Priority (1) - L. Barber

3. **Demonstrate feasibility of single-tree treatment using a helicopter.**

Low Priority - MTDC

D. Cooperative Field Projects

The following projects have been funded and are scheduled to be conducted in 1990. Assigning priorities to these funded projects was not deemed to be applicable. No other cooperative field projects are recommended as results of 1989 field tests are unknown at this time.

1. Conduct a field test (replicated) in two or more southern pine seed orchards to control Dioryctria using undiluted B.t. applied by aircraft at 30 BIU per acre.

L. Barber

2. Conduct field tests (replicated) in two Oregon seed orchards using a regime of pesticide and number of treatments, applied by both aircraft and ground sprayers to control a Douglas-fir pest complex.

R. Sandquist

3. Conduct a project to evaluate feasibility of a pheromone to disrupt mating of Dioryctria disculsa.

L. Barber

4. Conduct a field project to evaluate stem implants of acephate, metasystox, and dicrotophos to control seed and cone insects in R-1 and R-8.

L. Stipe
J. Negron

5. Continue field evaluation of Capture (a synthetic pyrethroid) to control seed and cone insects.

L. Barber

E. Equipment and Technology Development

1. Develop a tree injection or infusion method that is safe, economical, and minimizes tree damage. High resin levels in pines present a tough problem.

High Priority - WO/Engr.

2. Conduct an engineering study to evaluate both ground and aerial equipment for dispersal of pheromones in fibers, capsules, flakes, pellets, and granules. The study, to be conducted in close coordination with FIDR should evaluate existing hardware and identify need for hardware development.

Medium Priority (1) - WO/Engr.

3. Evaluate existing or develop new hardware for applying aerial sprays to single or clustered trees. Seed collection trees in wild stands seldom can be treated effectively from the ground. Aerial application currently is the only practical method of treatment. A helicopter spray system is needed. This may simply involve testing or modifying an existing system.

Medium Priority (2) - WO/Engr.

F. Information Management

Prepare a reference of labels and Material Safety Data Sheets (MSDS) on pesticides registered to control seed and cone insects.

High Priority - J. Barry

G. Administrative

1. Develop and maintain seed and cone insect management skills in Regions and NA.

High Priority (1) - J. Space

2. Contact EPA and discuss need to classify pesticides used for seed and cone insect control as non-food crop and relaxation of pheromone pesticide registration requirement.

High Priority (2) - M. Ollieu
G. DeBarr

3. Determine allocation of resources at Regions (TM and FPM), NA, and Stations for managing seed and cone insects; and to communicate to decision makers need for more research on reducing losses from seed and cone insects.

High Priority (3) - M. Ollieu

4. Develop an IPM decision making approach to manage seed and cone insects.

High Priority (4) - M. Haverty

5. Encourage evaluation and testing of new pesticides and biorational methods to control seed and cone insects, recognizing the susceptibility of dimethoate (Cygon) and azinphos-methyl (Guthion) to de-registration.

High Priority (5) - M. Ollieu

6. Invite a seed and cone scientist from academia to join this committee.

Medium Priority (1) - J. Barry

7. Recommend that persons who develop seed and cone insect project proposals submit their proposals to this committee for constructive review.

Medium Priority (2) - M. Ollieu

H. Operating Guidelines

1. Expand scope of this committee to include all methods of managing seed and cone insects and propose that the committee name be changed to National Steering Committee - Management of Seed and Cone Insects.

2. Conduct of field tests (experiments) in seed orchard and wild stand collection sites shall follow applicable parts of <u>Recommended Guidelines for Designing Field Experiments of Insecticides for Control of Insect Defoliators by Aerial Application</u> drafted by Pat Shea 8-8-89.

III. ACCOMPLISHMENTS

A. Committee's 1988 Recommendations and Accomplishments. Summarized below are accomplishments related to the committee's recommendations.

1. Field Experiments and Related Studies

a. PSW is continued research on impact of seed and cone insects on ponderosa pine, western white pine, and sugar pine (see Hagerty Appendix B).

b. PNW is continued research on a monitoring system for Douglas-fir seed chalcid and pheromone identification of the fir coneworm.

c. James B. Hoy and Michael I. Haverty described by the authors in Pest Management in Douglas-fir Seed Orchards: A Microcomputer Decision Method, General Technical Report PSW-108, Sept. 1988.

d. PNW and SE conducted some limited field work with pheromones to evaluate use of mating disruption to manage *Dioryctria disclusa*.

e. Some promising insecticides were evaluated in the East (B.t. aerially applied and chemical pesticide implants) and in the West (Guthion and Asana XL aerially applied and chemical implants in larch and ponderosa pine).

f. PNW, R-6, and WO/FPM evaluated several techniques to measure pesticide spray deposition and coverage during a cooperative field project at the Heather Orchard, Willamette NF.

2. Demonstrations and Pilot Projects

a. Some limited work was accomplished by R-6 and R-8 in looking at the environmental fate of pesticides. No work was done to study the fate of ultra low volume applications.

b. Utility of the Forest Service Cramer-Barry-Grim (FSCBG) aerial spray model was evaluated by WO/FPM (Davis) in cooperation with R-6 during the Heather Orchard project.

3. Administrative

a. WO/FPM in cooperation with WO/FIDR, PNW and SE have been negotiating with EPA on the issue of experimental use permits and pesticide exemption for pheromones.

b. R-8 has initiated their 5-year seed and cone action plan.

c. Funds have been made available to SE/R-8 to consolidate the Southeast's pheromone data-base with a 1991 target completion date.

B. Committee Member Reports

Reports by committee members Larry Barber and Jose Negron, Mike Haverty, Gary DeBarr and John Taylor are enclosed in Appendix B.

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Seed and Cone Insects met in Salt Lake City, UT, on November 8-9, 1989. The committee reviewed and discussed 1988 recommendations, 1989 field projects, and developed recommendations for furthering and improving management of seed and cone insects. The committee membership was expanded to include State and industry cooperators, and an invitation was extended to Canada to send representatives. The committee was pleased with progress of field work during 1989, but continues to emphasize the need to adequately support field work. The committee is especially concerned that there are too few chemical pesticides available and that some of these may be in jeopardy of de-registration. The committee further suggested that the committee's name and scope be changed to include all methods of managing seed and cone insects. The committee's next meeting is planned for Portland, OR or Eugene, OR, June 12-14, 1990, hosted by Roger Sandquist and Chris Niwa.

APPENDIX A
OPERATING GUIDELINES

OPERATING GUIDELINES
FOR
NATIONAL STEERING COMMITTEES
CONSIDERING
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FOR THE
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APPENDIX B
Larry Barber &
Jose Negron

REGION 8 PILOT PROJECT STATUS THROUGH OCTOBER 1989

PRESENTED TO THE NATIONAL SEED ORCHARD STEERING COMMITTEE

NOVEMBER 8, 1989

SALT LAKE CITY, UTAH

LARRY R. BARBER AND JOSE NEGRON

FORAY AERIAL APPLICATION PROJECT

Foray was sprayed at 30 BIU'S per acre neat and the primary insect targets were coneworms, Dioryctria spp. The pilot project was conducted on slash pine in the Florida Division of Forestry Seed Orchard near Munson, Florida. We used two insecticide treatments (two blocks of each) and one untreated block. The treatments were Foray and Foray (.625 ga./ac.) plus Asana XL (5.2 oz/ac.). The latter treatment should have controlled the entire compliment of seed and cone insects including seed bugs while the Foray treatment alone should have controlled only coneworms. The sample trees were sprayed five time from May through September. The insecticides were applied with a Thrush fixed wing aircraft fitted with six micornair AU 5000 rotary atomizers.

Coneworm damage in the untreated block was 29.28 percent as compared to damage ranging from 2.84 to 9.45 percent in the insecticide treated blocks Appendix 1. There does not appear to be a difference between insecticide treatments as far as coneworm damage is concerned. We have not collected the conelet crop at this time therefore we have no data to determine seed bug control by the two insecticide treatments.

This study needs to be repeated next year in several sites to further validate this years work. If further studies yield similiar results then the safety and cost of the product would make it the overwhelming favorite of the southern orchard managers. The cost of material applied per acre would be less than $10 per application as compared to $30-40 for conventional insecticides such as Guthion or Asana.

CAPTURE/TALSTAR AERIAL SPRAY TRIALS

Capture was applied to two seed orchards during 1989. The tests were in the Union Camp, second generation loblolly complex near Claxton, Ga and the other was in the Container Corporation of America second generation loblolly orchard near Brewton, Al.

The Union Camp orchard was sprayed 5 times during the summer at a rate of 10 gallons of solution per acre. Capture was applied at 0.3 lbs a.i./ac. and Guthion at 3 lbs a.i./ac. There were three treatments, including a untreated check with three replicates of each. Both the Capture and Guthion 2L treatments appear to be better than the untreated plots for the control of conewoms Appendix 2. Coneworm damage in the untreated blocks was 11.41 percent as compared to 4.81 and 4.44 percent in the Capture and Guthion treated blocks respectively. This data has not been analyzed. The seed have not been extracted, therefore there is no seed bug control data.

The Container Corporation of America was the site of the second test of Capture. Capture and Guthion 2L were applied with an AgCat aircraft using six micronair AU 5000 rotary nozzles. Both insecticides were applied at rates of one gallon per acre. The Capture was applied at 0.3 lbs a.i./ac. and the Guthion at 1.0 lbs. a.i./ac. The Guthion was applied neat and the Capture was applied with an appropriate amount of vegetable oil to bring the mixture up to one gallon per acre. We made three treatments to the orchard blocks during the spring and summer of 1989. There were 2 replicates of each treatment block ie., Capture, Guthion, and untreated.

There were no cones on the trees during 1989 because of a hard freeze during the flowering period in March 1988. Our primary emphasis in this study was to control seed bugs on the 1989 flower crop during the summer of 1989. In 1990 we will increase our spray schedule to control all seed and cone insects. We did however notice that in the two insecticide treatment blocks by the end of summer there were more surviving flowers than in the untreated blocks Appendix 3. This indicates a reduction in seed bug populations in the two treatment areas as compared to the untreated checks. Flower and conelet losses are often associated with feeding by seed bugs.

[illegible]

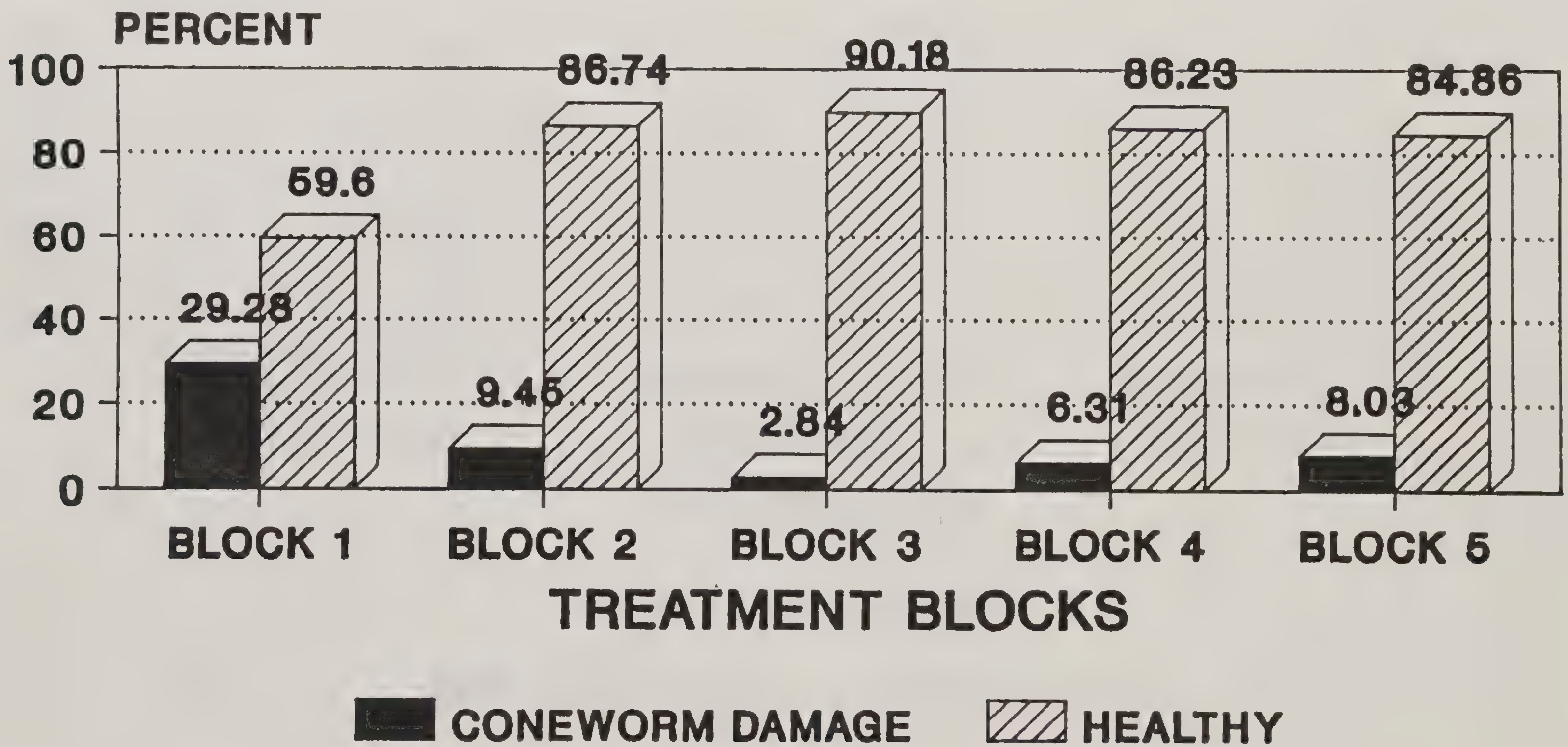
There were three treatments including an untreated check with four replicates of each. [illegible] treatments appear to be [illegible] the control of [illegible] Agal [illegible] untreated blocks was [illegible] 14 per [illegible] in the [illegible] respectively. The [illegible] have not been extracted [illegible] larvae.

The [illegible] Corporation [illegible] second test of Capture [illegible] with an AgCat [illegible] using [illegible] nozzles. Both insecticides [illegible] gallon per acre. The Capture [illegible] 200 [illegible] applied [illegible] and the Capture was applied [illegible] pounds of [illegible] acre. We [illegible] treatments [illegible] replicates of each treatment [illegible]

There were no [illegible] during 1989 because of [illegible] during the flowering [illegible] primary emphasis in this study was to control seed [illegible] the 1989 [illegible] crop during the summer of 1989. [illegible] use our spray schedule to control [illegible] insects. We did however notice that [illegible] plots at the end of summer were [illegible] than in the untreated plots [illegible] This [illegible] a reduction in [illegible] as compared to the untreated [illegible] losses are often associated with [illegible]

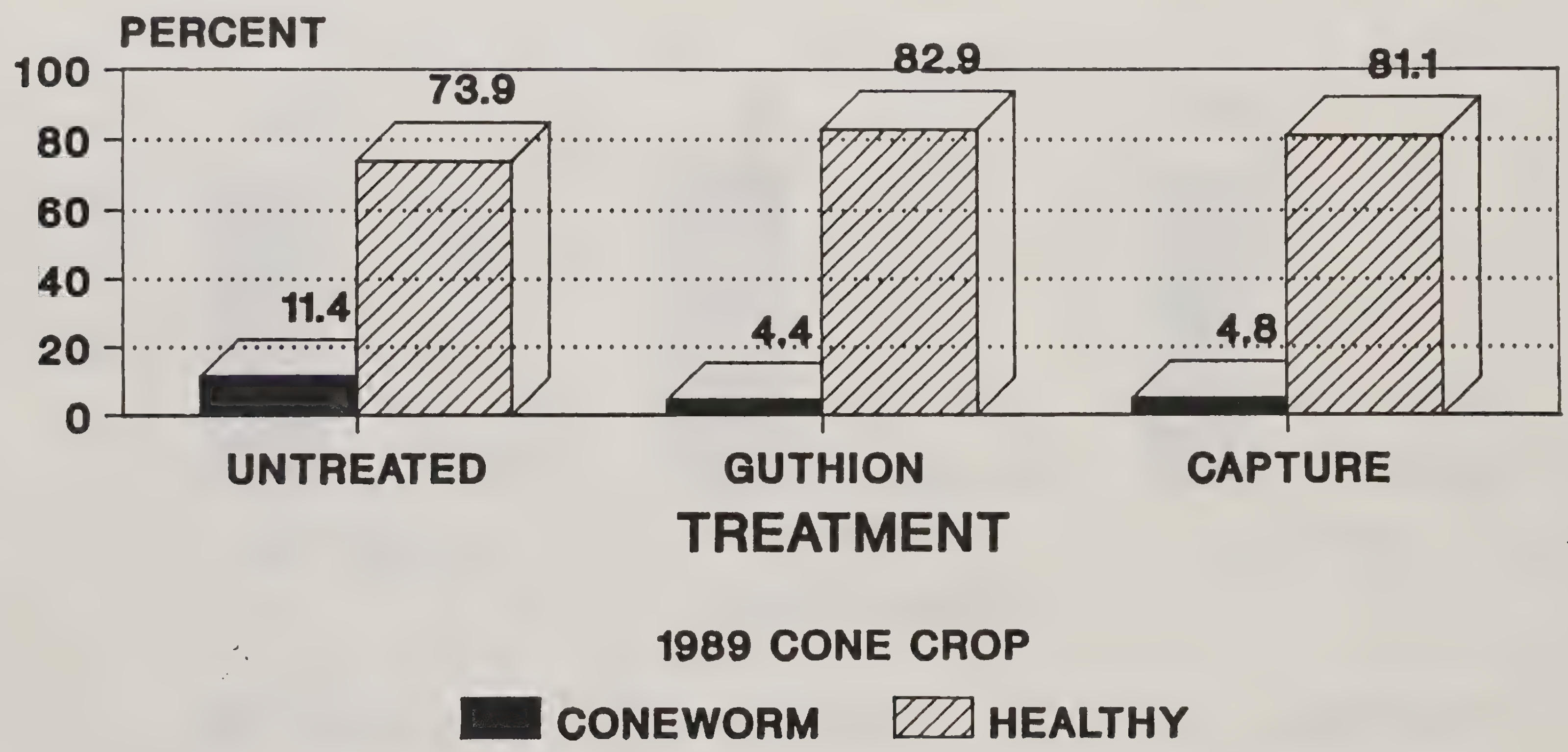
1989 FORAY PILOT PROJECT
MUNSON, FL.
1989 CONE CROP

70' trees



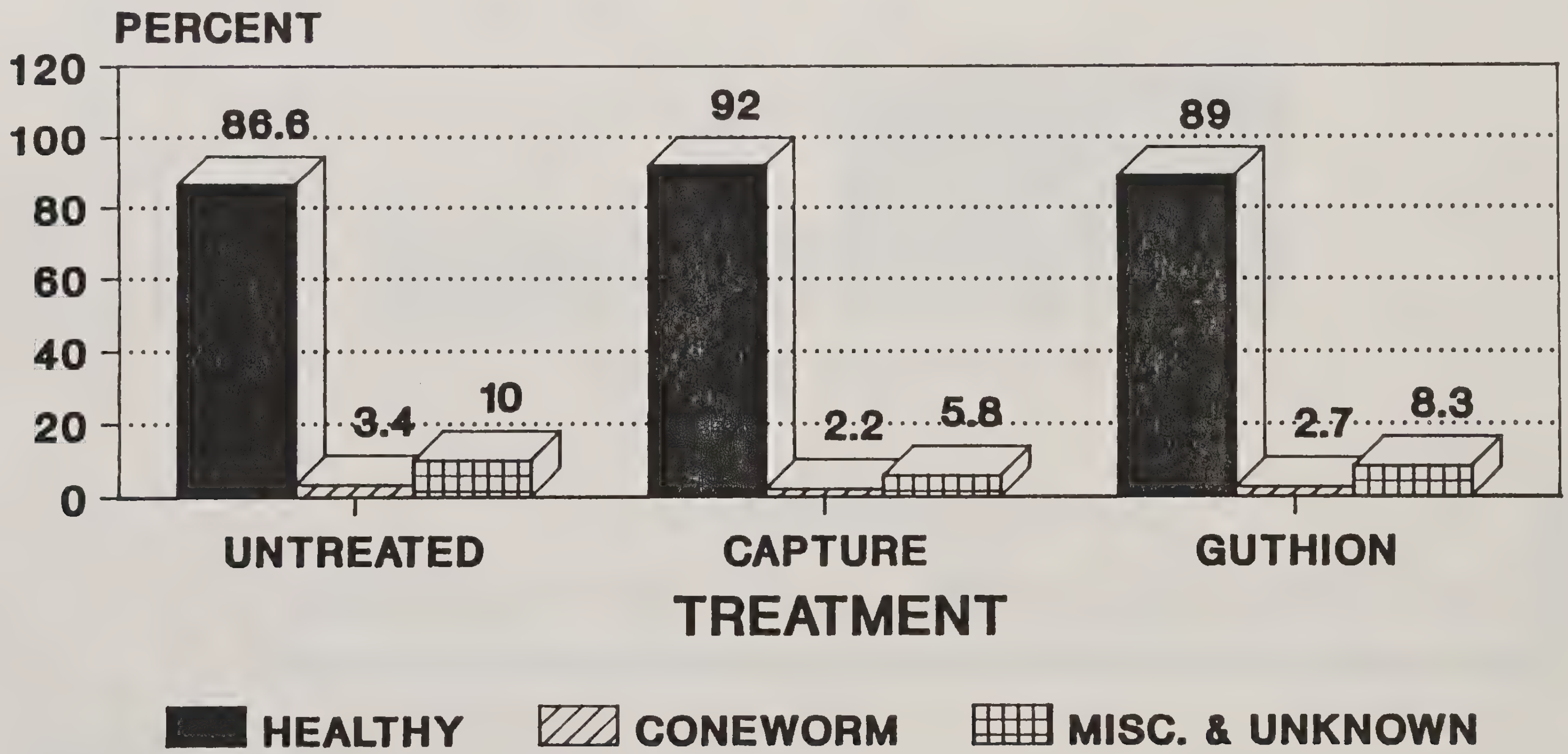
BLOCK 1 = UNTREATED
BLOCKS 2&3 = FORAY 30 BIU
BLOCKS 4&5 = FORAY + ASANA

1989 CAPTURE PILOT STUDY
UNION CAMP CORPORATION
CLAXTON, GEORGIA



GUTHION 3 LBS/AC
CAPTURE 0.3 LBS/AC
SOLUTION AT 10 GA/AC

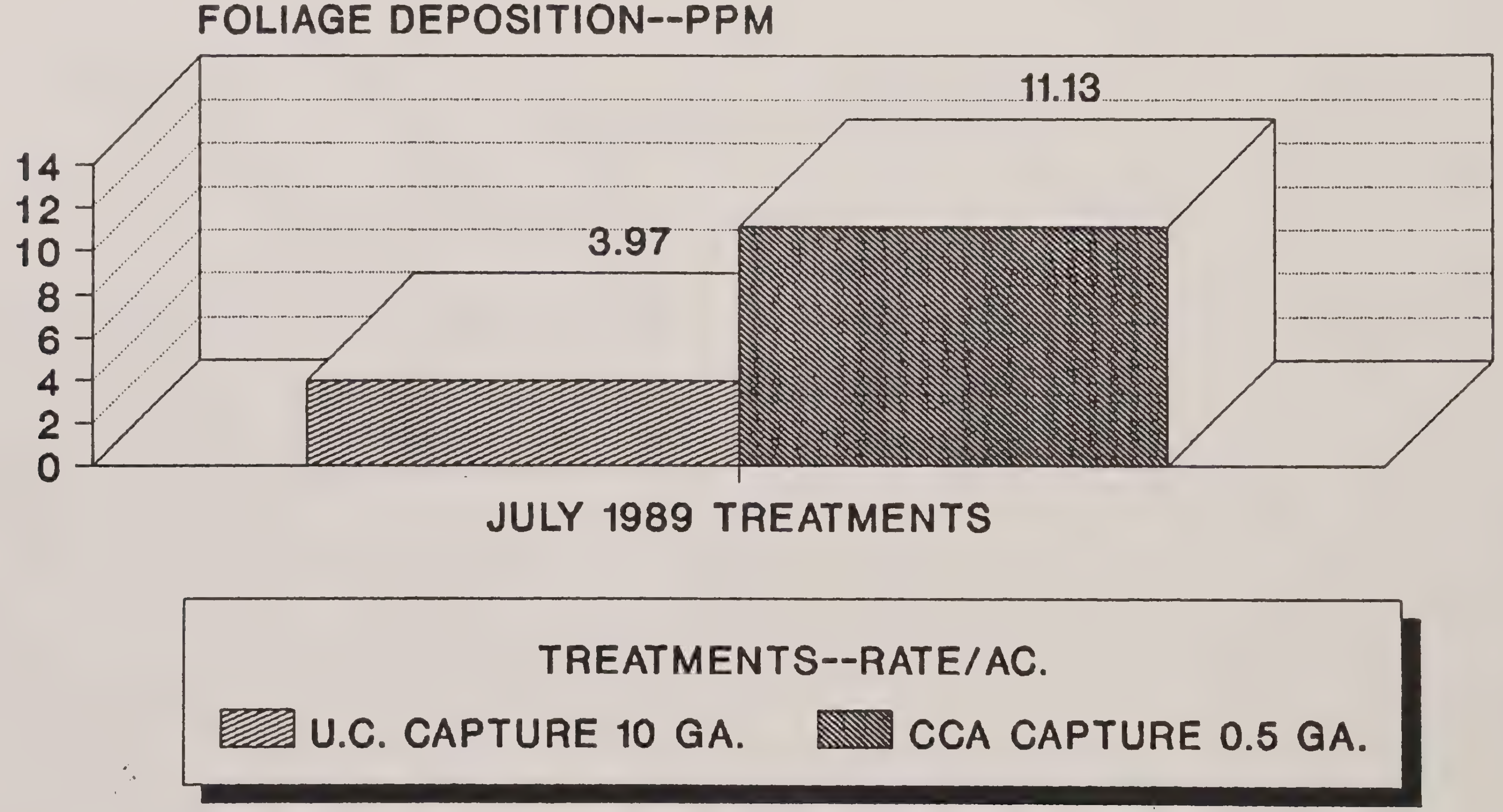
1989 CAPTURE PILOT PROJECT
BREWTON, AL.
1989 FLOWER CROP



CAPTURE 0.3 LB. A.I./AC.
GUTHION 1.0 LB. A.I./AC
SOLUTION = 1 GAL./AC.

FOLIAGE DEPOSITION DATA

HIGH VS. LOW VOLUME AERIAL APPLICATION CAPTURE APPLIED @ 0.3 LBS. A.I./AC.



UNION CAMP--CLAXTON, GA. 10 GA./AC.
CCA--BREWTON, AL. 0.5 GA./AC.

APPENDIX B
Mike Haverty

1989 REPORT FOR THE NATIONAL STEERING COMMITTEE
AERIAL APPLICATION OF PESTICIDES--SEED AND CONE INSECTS

Michael I. Haverty, PSW Station, Berkeley

Our Research Work Unit did not conduct, nor were we cooperators, in field tests, pilot tests, administrative studies, demonstrations or operational control projects that involved aerial application of pesticides for control of seed and cone insects. Our research program is comprised of projects in four basic areas: biology, impact, systemic insecticides, and ground application of insecticides.

Biology

1. Characterization of cuticular hydrocarbons for identification of cone and seed-damaging insects is a significant effort in our group. The insects of particular concern are the cone beetles (Conophthorus), cone worms (Dioryctria) and other cone-feeding insects such as Choristoneura and Leptoglossus. The purpose of these studies is to investigate another set of taxonomic characters (hydrocarbons) for species identification. Correct identification of an insect species is critical to the study of the biology of "pest" species. Development of pest management strategies requires correct identifications. For many of the insects listed above, there is a paucity of information on biology or species status of the insects that infest cones of pines and Douglas-fir.

2. Related to the hydrocarbon investigations are studies of isoenzymes and DNA restriction fragment length polymorphisms of cone and seed insects. Currently these studies are limited to Conophthorus and Dioryctria. The former genus now has a good biological and taxonomic data base. The latter genus is in critical need of additional taxonomic, genetic and biological clarification.

3. This year one of our entomologists initiated a cooperative project in France to develop "bait-and-switch" technology to disrupt host-location in the Douglas-fir seed chalcid, Megastigmus spermotrophus. From previous experiments we know that this insect utilizes volatile host kairomones to locate suitable oviposition sites. To identify the chemical cue(s), a technique was developed using a chromatographic substrate to trap volatile chemicals from cones and foliage. The technique was refined, and cones and foliage were sampled from susceptible and resistant clones throughout the growing season. Chemical profiles will ultimately be associated with cone phenology and chalcid attack rates. Early results suggest that chalcids may exploit differences in monoterpene compositions of cones and foliage to locate oviposition sites. Electroantennogram and olfactometer studies will confirm the attractive nature of fractions unique to cones. Field assays will follow.

Impact

1. We have been working for nearly 7 years on a study to determine the annual variation in the distribution of damage caused by cone and seed insects in Douglas-fir seed orchards in California, Oregon, and Washington. The original and primary purpose of this survey was to identify the most important or damaging insects to set priorities for our research program. A secondary goal was to ascertain the role of geography, genetics and adjacent land uses in

relation to seed losses. We also provided a service by informing seed orchard managers of the severity of insect problems in their orchards.

2. One of the insects for which we need additional information for all species of conifers in the West is the western conifer seed bug, Leptoglossus occidentalis. We have been investigating a preferential staining technique for L. occidentalis to see if we can identify puncture wounds in individual seeds or cones. Nymphs and adults possess polygalacturonase (PGAs) and pectinmethylesterase (PMEs) in their salivary enzymes and are capable of depolymerizing various plant matrix heteropolysaccharides. These enzymes are injected by these bugs into the plant through their mouthparts to facilitate feeding. Puncture-wounds in cones scales resulting from pectinmethylesterase activity in the saliva of these bugs were visualized by staining with a 0.05% aqueous solution of ruthenium red. This staining technique has been used to identity feeding damage by L. occidentalis on cones of sugar pine, western white pine and Douglas-fir. Further research is planned to take advantage of this technique for 'real-time' assessment and monitoring of seed bug damage in orchards. In addition, this preferential technique will be tested on individual seeds and other reproductive tissue ie., primordial cone buds, flowers, and conelets.

3. We are increasing our understanding of the impact of insects in blister rust-resistant western white pine and sugar pine seed orchards in western Oregon and California. In 1989 two bagging studies were initiated to determine the phenology of insect occurrence and impact in western white pine (Dorena Tree Improvement Center) and sugar pine (Charles E. Sprague) orchards. In each study used 6 bagging periods (treatments) plus a completely unbagged and completely bagged treatment.

4. Life table studies of ponderosa pine cones have been established in a seed orchard in central California and in natural stands in Washington and Oregon (in cooperation with R.E. Sandquist, R-6). The objectives of these studies are to identify, quantify, and determine the biologically-important mortality factors (insects and other biotic and abiotic factors) of ponderosa seed and cones. Preliminary data from the orchard study indicate that there is a significant difference in conelet mortality between seed zones, among clones within seed zones and among crown strata within clones. The factors responsible for this mortality have yet to be determined.

Systemic Insecticides

1. We are studying accumulation and temporal distribution of the systemic insecticide, acephate (in Acecaps), in western larch. So far we have only been able to determine translocation of acephate from bole-implanted capsules to foliage, because the cone flowers have been destroyed by frost. In addition to acephate, several other systemic insecticides may be tested. These include carbofuran, dimethoate and possibly a synthetic pyrethroid (the systemic nature of these insecticides is not known). Similar studies are also planned for Douglas-fir in California.

2. Timing of insecticide implants is another variable under investigation. In ponderosa pine the objectives are to measure residues within the crown and to determine the distribution patterns attributed to fall or spring applications. This should provide background information when considering the best management

strategy for specific insects. In Douglas-fir implanting acephate in the spring at bud burst, or when cones are turning pendant, significantly reduced damage by the fir coneworm and the Douglas-fir cone moth. Infestation levels of Douglas-fir cone gall midge and the Douglas-fir seed chalcid were not affected. We have initiated cooperative studies with R-6 to investigate fall and spring implants of acephate, dimethoate and carbofuran to determine the effect of seasonal implants on all four cone insects. We are particularly interested in effective implant timing for the gall midge and seed chalcid. New systemic insecticides will need to be evaluated to control these latter, important pests of Douglas-fir seed production.

3. Another approach under investigation is the translocation of micro-encapsulated systemic insecticides within the xylem of conifers. The usual methods of applying systemics are: (1) spray aqueous solution on foliage, (2) incorporate insecticide into the soil, (3) inject fluid insecticides into the bole, or (4) implant a capsule containing an insecticide into the bole of the tree. The approach we will try next field season is to drill holes in the boles and place micro-encapsulated insecticides, carbofuran and carbosulfan, directly into the tree. We plan to test this strategy in the major conifer species in California--Douglas-fir, ponderosa pine, sugar pine, and white fir. To begin with, we will measure insecticide levels only in foliage and cone tissues. Assessment of efficacy may come next.

4. A comparison of efficacy of implanted acephate and ground applications of dimethoate for protection of Douglas-fir seed crops was initiated in four seed orchards in Oregon. Seed production has yet to be analyzed, but preliminary indications are that both treatments reduced the amount of damage by lepidoptera (primarily Dioryctria) and Douglas-fir cone gall midge, but not in all orchards. Orchard location clearly affected the results.

Ground Application of Insecticides

1. An assessment of efficacy of single or multiple applications of esfenvalerate for protection of blister rust-resistant western white pine seed crops in Oregon was started this season. This strategy and insecticide have been found effective in northern Idaho and is being verified at the Dorena Tree Improvement Center where we have a more complete complex of cone and seed pests. The insecticide is a new formulation of the most toxic isomer of fenvalerate. Early indications are that the cone crop was too large and the insect population too small to assess efficacy. We'll known soon!

Hoy, James B.; Haverty, Michael I. 1988. **Pest management in Douglas-fir seed orchards: a microcomputer decision method.** Gen. Tech. Rep. PSW-108. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 29 p.

The computer program described provides a Douglas-fir seed orchard manager (user) with a quantitative method for making insect pest management decisions on a desk-top computer. The decision system uses site-specific information such as estimates of seed crop size, insect attack rates, insecticide efficacy and application costs, weather, and crop value. At sites where information on insect attack is not available, regional attack rates within the program may be used. The heart of the decision system is a payoff analysis. It evaluates alternative management actions and identifies the best action under the best or worst conditions, and the action that minimizes the opportunity cost. Tutorial help is included in the program as well as utility programs for entering local weather data.

Retrieval Terms: Douglas-fir, seed orchard, pest management, pest control decision method, payoff analysis, frost damage probability estimation

The Authors:

JAMES B. HOY is a research entomologist with the Station's research unit studying insect biology and control, in Berkeley. During the genesis of this report, he was a research associate in the Division of Biological Control, Department of Entomological Sciences, University of California, Berkeley.

MICHAEL I. HAVERTY is a principal research entomologist and leader of the research unit.

Acknowledgments:

We had the help of many members of the Northwest Seed Orchard Managers' Association in preparing this decision system. We thank Donald L. Dahlsten, for his encouragement, David L. Rowney for his programming assistance, and William A. Copper for preparing flowcharts. Michael A. Bordelon, William R. Cook, and Gordon E. Miller kindly reviewed the manuscript and provided many helpful suggestions. This project was supported, in part, through a cooperative aid agreement between the Pacific Southwest Forest and Range Experiment Station and the Division of Biological Control, Department of Entomological Sciences, University of California, Berkeley.

Publisher

Pacific Southwest Forest and Range Experiment Station
P.O. Box 245
Berkeley California 94701

September 1988

APPENDIX B
Gary DeBarr

Nov. 1989

Gary L. DeBarr, Research Entomologist
SE-4501 Athens, Georgia

Current Research:

1) Use of prescribed fire to control the white pine cone beetle in eastern white pine seed orchards. (DeBarr, Barber, Manchester and Wade).

Objective: To determine the feasibility of using fire as an alternative to insecticides for cone beetle control.

2) Mating disruption of *Dioryctria* spp. using synthetic sex pheromone deployed in seed orchard trees. (DeBarr, Nord and Niwa)

Objective: To determine the feasibility of using mating disruption to control coneworms, *Dioryctria* spp., in loblolly pine seed orchards.

3) Demonstration and identification of pheromones for the white pine cone beetle. (DeBarr, Birgerson and Berisford)

Objective: To show that *C. coniperda* produces and uses pheromones and to chemically identify pheromone components.

4) Effect of temperature on the development of *L. corculus* and *T. bipunctata*. (Nord, DeBarr, and McGuiness)

Objective: To determine the relationship between temperature and insect development and to develop degree-day models for *L. corculus* and *T. bipunctata* for timing control applications and predicting number of generations/year across southern U.S.

5) Determination of feeding impact of 2nd-stage *L. corculus* nymphs on loblolly pine conelets. (Nord and DeBarr)

Objectives: a) To determine the number of ovules destroyed/nymph/day. b) To determine the number of ovules destroyed/day/nymph among seasons and clones. c) To determine the number of damaged ovules required for conelet abortion.

6) Pheromone detection of *Dioryctria* spp. in Southern pine seed orchards: Analysis of 10 years of Southwide trapping data.

Objectives: a) To integrate existing information into one data base accessible by microcomputers for use by researchers and practitioners. b) To analyze trapping data for population trends, regional distributions, species interactions, activity periods, data varibility and damage preditions.

7) Outbreaks of scale insects associated with pyrethroid use in southern pine seed orchards. (Clarke, DeBarr, Negron and Berisford).

Objectives: To determine why scale insect populations increase following the use of pyrethroids for cone and seed insect control. b) to compare pyrethroids and develop guidelines to minimze outbreaks in orchards.

1989 WHITE PINE CONE BEETLE PHEROMONE STUDY

Gary L. DeBarr, Goran O. Birgersson, and C. W. Berisford

OBJECTIVE: To demonstrate the presence of pheromones of the white pine cone beetle, Conophthorus coniperda, chemically identify those pheromones, and to conduct preliminary studies on their utility of integration into control programs

METHODS: Volatiles from air passed over unifested eastern white pine cones, or cones infested by male or female white pine cone beetles were collected on Porapac. Ether extracts of the Porapac were bioassayed for male and female response in the laboratory. Compounds were identified by GLC-mass spectroscopy. Attraction to male and female infested cones, extracts, and synthetic pheromones were evaluated during the spring attack period in the USFS Beech Creek Seed Orchard using two types of traps suspended in the tree crowns.

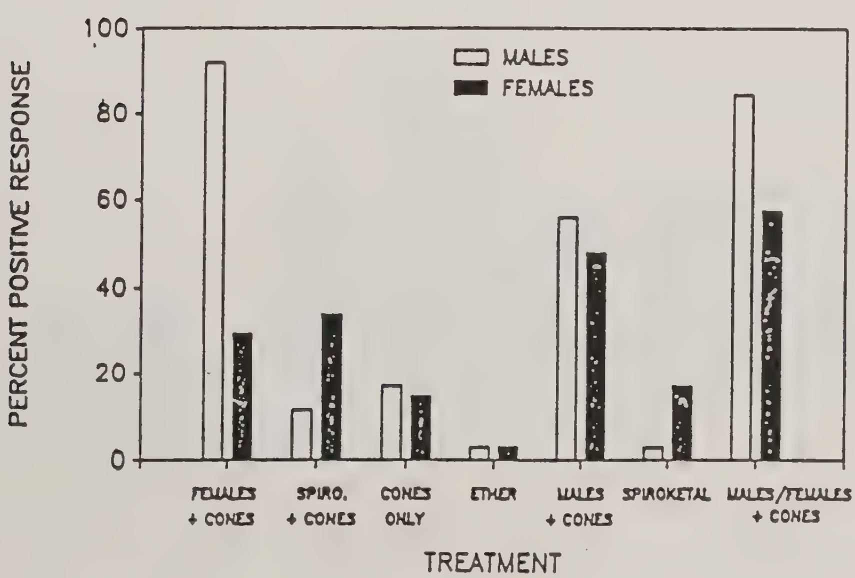
RESULTS: Both males and female beetles produced compounds with pheromonal activity. Preliminary laboratory and field bioassays indicate the presence of chemicals which appear to function as aggregating pheomones, anti-aggregating pheromones, and sex pheromones (female attracting male). All the pheromone components, except for one female produced alcohol have been unequivocally identified. Pheromone production changes throughout the spring emergence and attack period. Beetles must be allowed to emerge naturally in order to produce pheromones, but flight is not a necessary prerequiste for pheromone production.

ADDITIONAL WORK: Studies to investigate the utility of pheromones for monitoring and control of the cone beetle are continuing through a two-year cooperatve grant with the University of Georgia.

Cooperative Special Project

A special project to demonstrate and evaluate new techniques to control the white pine cone beetle. (Barber FPM, Wade & DeBarr SE and others) 1990-1991

RESPONSE OF Conopthorus coniperda TO CHEMICAL STIMULUS



1989 DIORYCTRIA DISCLUSA MATING DISRUPTION STUDY

Gary L. DeBarr, John C. Nord, and Christine G. Niwa

OBJECTIVE: To demonstrate the feasiblity of using MD to control the webbing coneworm in loblolly pine seed orchards.

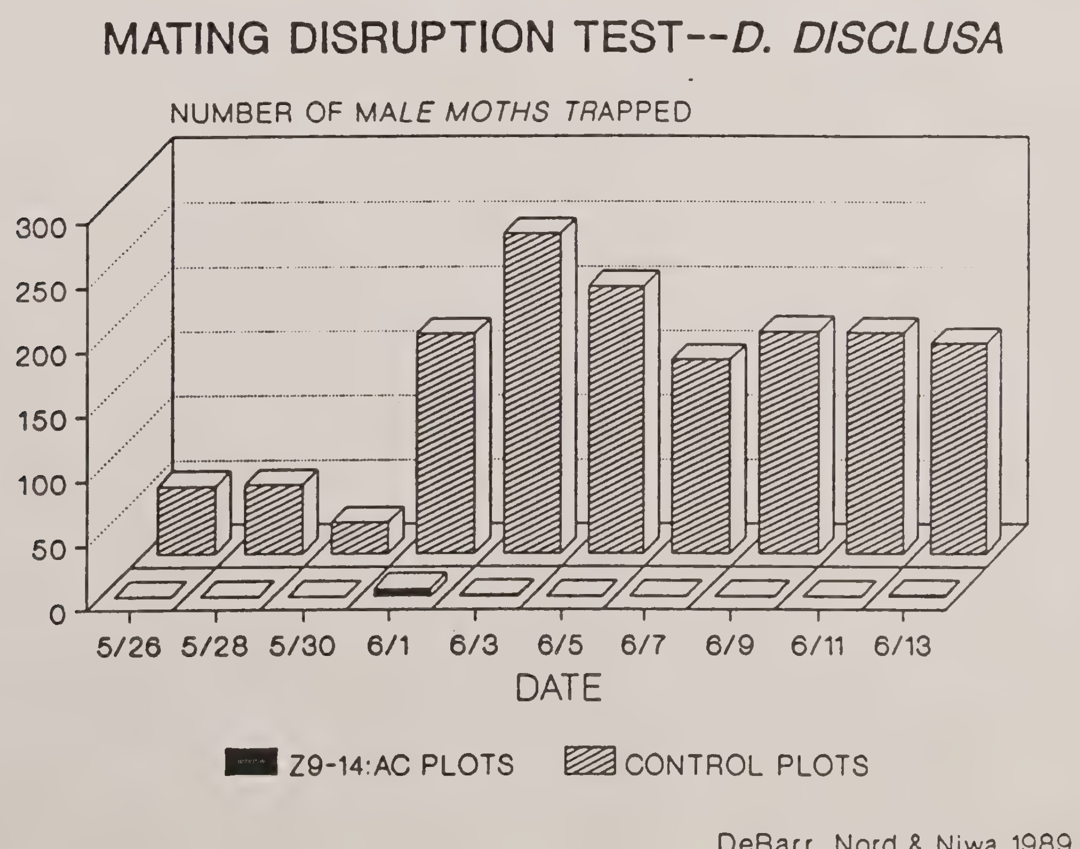
METHODS: Synthetic pheromone was released from PVC releasers placed in the mid- and upper crowns of 20 year old loblolly pines growing in the Meade Coated Board seed orchard, Putnam Co., Ga. The study was conducted in 2 plots of 3 acres each. Two releasers were suspended in each of 100 trees per plot for periods of 2 consecutive nights. Releasers were alternated between the two plots throughout the emergence period. The releasers contained 5 g of (Z)-9-tetradecenyl acetate per acre. Ten Pherocone 1C traps located in upper crowns of trees at the center of each plot were used to monitor male moth activity on treatment and non-treatment nights. The study was replicated in time, rather than space. The controls were nights without releasers; the treatments were nights with releasers in the trees.

RESULTS: Analyses showed that 35% of the pheromone was released during the 20 days of the test. Trap "shutdown" occurred on the nights the releasers were deployed. A total of 1507 D. disclusa males were trapped on control nights vs. 8 on treatment nights, for a 99.5% reduction in trap catch.

ADDITIONAL WORK: We will repeat this test during late August through early September to determine if (Z)-9-14:Ac will also disrupt D. merkeli. In additon, we will determine if (Z)-9-14:Ac permeation of the orchard will inhibit D. amatella.

Cooperative Special Project

A special project to demonstrate and evaluate control of the webbing coneworm, D. disclusa, by mating disruption. (Barber & Negron FPM, DeBarr & Nord SE, Daterman and Niwa PNW). 1990-1992,



APPENDIX B
John Taylor

Publications and Presentations from NAPIAP Funded Projects Administered by Region 8 Forest Pest Management

Intensive monitoring of insecticide off-site movement in seed orchards located in three physiographic provinces in the South. (R8-2)

PUBLICATIONS

Neary, D. G., P. B. Bush, W. L. Nutter, and J. W. Taylor. 1989. Pesticide movement from Southern Pine Seed Orchards: I. Measured and Simulated Azinphosmethyl and Carbofuran in stormflow from a Georgia Piedmont Orchard. Submitted to Forest Science.

Nutter, W. L., P. B. Bush, D. G. Neary, R. McKenna, and J. W. Taylor. 1989. Pesticide Movement from Southern Pine Seed Orchards: II. Risk Assessment for insecticides in storm flow from a Georgia Piedmont Orchard. Submitted to Forest Science.

Taylor, J. W., D. G. Neary, and P. B. Bush. 1988. Pesticide residue sample collection. Protection Rep. R8-PR11. USDA For. Ser., Southern Region, Atlanta, GA. 5pp.

Insecticide distribution and persistence after spray application in Seed Orchards.

PUBLICATIONS

*Bush, P. B., W. L. Nutter, D. G. Neary and J. W. Taylor. 1989. Pesticide Movement from Southern Pine Seed Orchards: Use of CREAMS Model to facilitate evaluation of off-site pesticide movement. CREAMS/GLEAMS Symposium. Univ. of Georgia. Athens, Georgia.

Lindane Fate and Movement in an Upper Piedmont Forest Ecosystem. (R8-14)

THESIS:

James B. Feild, Water Movement and Chemical Transport in a Loblolly pine Forest. Masters Thesis, University of Georgia, Athens, Georgia.

Peter Ketcham, Groundwater Tracing in a North Georgia Piedmont Regolith by

Natural Oxygen-18 tracing, 1980. Masters Thesis Geology Department, University of Georgia, Athens, Georgia.

Joan Miller, Fate of Lindane in a Georgia Piedmont *Pinus taeda* Plantation. Masters Thesis, University of Georgia, Athens, Georgia. 1989.

PUBLICATIONS:

Bush, P. B., J. F. Dowd, J. Miller, and J. W. Taylor. 1988. Collecting

[illegible] L. P. [illegible]
[illegible] soil [illegible] from [illegible]
[illegible] in a Georgia [illegible]
[illegible] [illegible].

[illegible] W. L., P. B. [illegible] G. [illegible] and [illegible] 1989
[illegible] Southern Pine [illegible]
[illegible] flow from a Georgia [illegible]
to [illegible].

[illegible], T. W., D. G. [illegible], [illegible] 1986. [illegible]
[illegible] Bull. [illegible] Soc., Southern Region,
Atlanta, GA. 4pp.

[illegible] dissipation and persistence after spray application [illegible]
[illegible].

[illegible]

[illegible], W. L. [illegible] D. G. [illegible] 1985. [illegible]
[illegible] Southern Pine [illegible]
[illegible] evaluation of [illegible]
Symposium. [illegible], Georgia.

[illegible] Pests. [illegible]

[illegible] W.

[illegible]
[illegible] of [illegible]

[illegible] in a North [illegible] by

[illegible] Weed [illegible]
[illegible] Georgia.

[illegible]

Chemical and Physical parameters to describe pesticide movement in forested watersheds. Proceedings of Southern Weed Science Society, 41st Annual Meeting, Tulsa, Oklahoma.

Dowd, J. F., and A. G. Williams. 1989. Calibration and use of Pressure Transducers in Soil Hydrology. Hydrological Processes, Vol 3, pp-43-49.

Dowd, J. F., A. G. Williams, and P. B. Bush. 1989a. Influence of stemflow on lindane loading in the soil. Submitted to Water Resources Research.

Dowd, J. F., J. H. Miller, A. G. Williams, and P. B. Bush. 1989b. The Fate of lindane in a forested ecosystem. Submitted to Journal of Environmental Quality.

Abstract and Presentations at National and Regional Meetings

Bush, P. B. and J. F. Dowd. Pesticides in runoff from Forested Lands in the Southeast. American Chemical Society Symposium on Pesticide Runoff and Leaching Losses. American Chemical Society National Meeting, Dallas, Texas, 1989.

Bush, P. B., J. F. Dowd, A. G. Williams, D. G. Neary, and J. W. Taylor. Pesticides in Runoff from Forested Lands in the Southeast. Proceedings of a National Research Conference, "Pesticides in Terrestrial and Aquatic Environments", May 11-12, 1989, Richmond, VA; Virginia Water Resources Center, Virginia Polytechnical Institute and State University, W. R. Walker and D. L. Weigmann (eds.)

Dowd, J. F., A. G. Williams and P. B. Bush. Modelling the fate of lindane in a forested ecosystem. 7th Int. Cong. of Pest Chem. Hamburg, 1990.

Dowd, J. F., J. B. Feild, and P. B. Bush. 1989. Tracer movement in a Forest Soil. Annual Meeting of the Soil Science Society of America. Las Vegas, Nevada.

Field, J. B. Water movement and Chemical transport in a Loblolly Pine Forest. Georgia Water Resources Conference, University of Georgia, Athens, Georgia. 1989.

Wenner, D. B., D. Ketcham and J. Dowd. Charting changes in the stable isotopic composition of water during infiltration into the Regolith. Epstein 70th Birthday Symposium. Dec 1989, Calif. Inst. Tech. Pasadena, CA.

7) Malathion Fate and Movement in an Upper Piedmont Forest Ecosystem. (R8-17)

THESIS:

Hemmen, K. Tracer studies of Water Movement in Soil Cores from near Comer, Georgia.

Veenendaal, A. Water Infiltration in a North Georgia Piedmont Soil: Evaluation of the Effects of Stemflow Loading.

[illegible] 1969 [illegible] of Pressure [illegible] Physiology [illegible] 13-17.

[illegible] Bush. 1980. [illegible] of [illegible] in Soil. [illegible] Resources Data [illegible]

Dowd, J. F., J. H. Miller, A. G. Williams, and P. B. Bush. 1981. [illegible] Submitted to Journal of Environmental Quality.

[illegible] at National and Regional Meetings.

Bush, P. B. and [illegible]. Pesticides in runoff from [illegible] American Chemical Society [illegible] American Chemical Society National Meeting, Dallas, Texas. [illegible]

[illegible] P. B., J. F. Dowd, A. G. Williams, [illegible] Neary, [illegible] Taplin. [illegible] in Runoff from Forested Lands in the [illegible] Proceedings of a National Research Conference. "Pesticides in Terrestrial and Aquatic Environments." May 11-12, 1984, Richmond, VA. Virginia Water Resources [illegible] Virginia Polytechnic Institute and State University. [illegible] Weigmann (ed.)

Dowd, J. F., A. G. Williams, P. B. Bush. [illegible] of [illegible] in [illegible] Forested [illegible] Int. Conf. of [illegible] Hamburg [illegible]

Dowd, J. F., J. S. [illegible], and P. B. Bush. 1984. [illegible] movement in a [illegible] Annual Meeting of the Soil Science Society of America. Las Vegas, Nevada.

[illegible] J. D. [illegible] and Chemical [illegible] in a [illegible] Regional Conference, University of Georgia, Athens [illegible]

[illegible]

[illegible] Movement in an Upper Piedmont Forest [illegible]

SECTION 3

SECOND REPORT

National Steering Committee for Application of Pesticides - Western Defoliators

April 17, 1990

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

APPENDIX

A. Operating Guidelines for National Steering Committee

B. Committee Member Reports

C. Guidelines for Design of Field Experiments and Pilot Projects

I. INTRODUCTION

The second meeting of the National Steering Committee for Aerial Application of Pesticides - Western Defoliators met in Albuquerque, New Mexico, October 11-12, 1989.

A. Committee Members

Roy Beckwith[2.]	PNW/FIDR (Corvallis, OR)
Jesus Cota	WO/FP (Washington, D.C.)
John Cunningham[1.]	Forest Pest Management Institute (Sault Ste. Marie, Ontario)
Gary Daterman[1.]	PNW/FIDR (Corvallis, OR)
Bob Ekblad[2.]	WO/ENGR/MTDC (Missoula, MT)
Kees van Frankenhuyzen[1.]	Forest Pest Management Institute (Sault Ste. Marie, Ontario)
Jim Hadfield[2.]	R-6(RO)FPM (Portland, OR)
Dennis Hamel[1.]	WO/FPM (Washington, D.C.)
Dave Leatherman[1.]	Colorado State Forest Service (Ft. Collins, CO)
Ladd Livingston	Idaho Department of Lands (Coeur D'Alene, ID)
John Neisess	R-5(RO)FPM (San Francisco, CA)
Max Ollieu	WO/FPM (Washington, D.C.)
Iral Ragenovich	R-6(RO)FPM (Portland, OR)
Pat Shea	PSW/FIDR (Davis, CA)
Larry Stipe	R-1(RO)TM (Missoula, MT)
Julie Weatherby	R-4(BFO)FPM (Boise, ID)
Jack Barry	WO/FPM Committee Chair (Davis, CA)

---

1. Absent
2. Ad hoc participants

B. Purpose of Committee

The purpose of the committee is to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

C. Agenda

Introduction
Review of 1988 Committee Recommendations & Accomplishments
Individual Project Reports and Discussions
Guidelines
Bibliography
Recommendations
Conclusions

D. Operating Guidelines for National Steering Committees (See Appendix A)

E. Committee member reports (See Appendix B).

F. The current draft of guidelines for designing field experiments and pilot projects are enclosed (See Appendix C).

II. RECOMMENDATIONS

Recommendations are listed in order of priority followed by the organization that should initiate action.

A. Laboratory

1. **Pursue laboratory testing of new B.t. strains.**

   New strains of B.t. that may have significantly higher efficacy against western defoliators should be tested in the laboratory as they become available.

   PNW

2. **Develop a plan to obtain data on impact of pesticides on non-target leptidoptera.**

   There is need for data on the impact of pesticides on non-target leptidoptera. There is only limited information in this area and the committee recommends that a plan be developed by PSW/PNW to

obtain this data. The plan would include field inventory, laboratory evaluations, field testing, and methods to fund and accomplish this work.

PSW/PNW

3. **Develop, identify, and evaluate improved carriers for TM-Biocontrol.**

   The molasses carrier for TM-Biocontrol is a difficult to mix and apply in the field. There is need to investigate carriers that have been used for other biologicals and/or to develop new carriers. The committee recommends that PNW pursue this and evaluate carriers that show promise in the laboratory.

   PNW

4. **Explore techniques for rapid bio-assay of microbials.**

   There is need to determine the potency of microbial tank mixes immediately before spray operations. Bruce Hammock, University of California (Davis) Entomology Department may have developed an enzyme link immunosorbant assay (ELISA) method of determining potency. Pat Shea volunteered to explore the status and applicability of this technique and report to the committee.

   PSW

5. **Determine evaporation rates and physical properties of microbial tank mixes.**

   Data on evaporation rates and physical properties are needed for operational use of new microbial tank mixes and for input to the AGDISP and FSCBG aerial spray models. WO-FPM (Davis) jointly should explore ways to obtain this information.

   WO/FPM

6. **Obtain spread-factors for all microbial tank mixes.**

   Spread factors are essential to quantify the deposition (drop size and volume deposited) of aerial sprays. Without representative spread factors we cannot compare formulations, improve atomization, or quantify the quality of application including spray drift. WO-FPM (Davis) should pursue this task.

   WO/FPM

B. Field Tests

1. **Conduct field tests of new strains of Bacillus thuringiensis (B.t.) against western spruce budworm as recommended by PNW (Project 4502).**

   The committee places a high priority on field testing microbials that have demonstrated significantly improved efficacy in the laboratory. We must be cautious, however, and have some level of confidence that the producer will be available to provide a registration and product for operational use.

   PNW

2. **Conduct field tests of improved tank mixes of TM-Biocontrol.**

   This is high priority and the committee recognizes that before field tests are conducted improved tank mixes will need to be developed.

   PNW

3. **Conduct mating disruption tests using pheromones against western spruce budworm and Douglas-fir tussock moth (DFTM) outbreaks.**

   Preliminary tests against western spruce budworm were done on a small scale in 1980. These tests showed promise. Tests are needed to evaluate mating disruption strategy on large size (1000A) blocks for western spruce budworm to minimize the confounding influence of mated females flying into treatment areas. DFTM mating disruption would be tested on a pilot scale but on smaller-sized plots (less than 500 acres are acceptable). The committee recognizes that qualifying populations of DFTM will be difficult to predict.

   PNW

4. **Conduct field experiments of Sandoz Crop Protection Corporation (Sandoz) product SAN 415 SC 32LV (NRD-12 strain, 32 BIU per gallon) against DFTM to obtain efficacy data.**

   SAN 415 is registered for spruce budworm and gypsy moth but not for DFTM in California. It is formulated identically to Thuricide 32LV except it contains the NRD-12 strain instead of the HD-1 strain. SAN 415 has not been adequately field tested Against the douglas-fir tussock moth; therefore, the committee recommends field testing of SAN 415 against This species when adequate populations are found. Sandoz prefers to provide SAN 415 for forestry over Thuricide 32LV and Thuricide 48LV, the former an NRD-12 strain, the latter two HD-1 strains. The main production product at the Sandoz, Wasco, CA facility is Javelin,

an NRD-12 strain, for the agriculture market. It would be relatively easy for Sandoz to produce SAN 415 as it contains the same strain as Javelin. Last year the committee discussed testing Javelin and decided against testing as it is not formulated nor registered for forestry. Testing of SAN 415 is consistent with the committee's operating guidelines of encouraging the private sector to develop and maintain forestry-use pesticides. The intent is to maintain more labels to encourage competition.

PNW

5. **Conduct field experiments of lower doses of TM-Biocontrol.**

   Laboratory results suggest that lower dosages DFTM virus may be effective and this needs to be evaluated in the field to determine the lower effective threshold. The committee feels that emphasis should be placed upon reducing costs through reducing dosages.

   PNW

6. **Conduct cooperative field tests of several dosages (0.5, 1, and 2 ounces per acre) of Dimilin against DFTM in California.**

   There is need to identify the lower effective dose range of Dimilin (diflubenzuron) against DFTM for economic and environmental reasons. The need to conduct tests in California parallels the need discussed in paragraph 4 above.

   PSW

C. Pilot Projects and Cooperative Field Tests/Pilot Projects

1. **Conduct cooperative pilot test of the Sandoz B.t. product SAN 415 against western spruce budworm.**

   Recommendation is subject to review by the committee of NRD-12 strain performance data and to Sandoz' intent to market SAN 415 for forestry use. If data are supportive, the committee may recommend operational use in lieu of pilot testing.

   PNW

2. **Conduct cooperative pilot test of TM-Biocontrol, double (spring and summer treatments) against new, low level, and sub-outbreaks of DFTM.**

   There are data that suggests a double treatment strategy using TM-Biocontrol might control early emerging infestations of Douglas-fir tussock moth. Such a strategy has significant potential for major cost/benefits.

   PNW

3. **Conduct pilot test of B.t. against new and low level outbreaks DFTM.**

   The above comments (III,C,2) apply.

   PNW

4. **Conduct pilot test of Dipel 8L and Dipel 8AF applied at 32 ounces per acre to control western spruce budworm.**

   The committee suggests that Abbott Laboratory conduct a pilot test to evaluate on an operational scale effectiveness of Dipel 8L and Dipel 8AF applied at ultra low volumes of 32 ounces per acre. The FS would be a cooperator with Abbott Laboratory bearing the major expense.

   Abbott Laboratories

D. Equipment, Models, and Technology Development

1. **Conduct airport spray trials to characterize Dipel 6AF.**

   R-6 is considering operational use of Dipel 6AF, however, we lack information on field handling, atomization, spray deposition, and swath widths for the improved formulation. The committee recommends that WO-FPM (Davis), in cooperation with Abbott Laboratory and R-6, conduct spray trials at Davis, CA to characterize Dipel 6AF.

   WO/FPM

2. **Evaluate and recommend methods of sampling ultra low volume (ULV) sprays on pilot and operational projects.**

   Monitoring spray deposit is an essential element on spray projects. Monitoring assesses the on and off target deposition and helps to determine if an adequate amount of spray reached the target. ULV sprays, which are applied in small drops, are difficult to detect due to visibility and tendency to deposit on objects smaller than traditional samplers. An inexpensive, rapid, and easy to use method is needed for use on pilot and operational projects.

   MTDC

3. **Evaluate existing aircraft guidance systems and provide recommendations for operational deployment.**

   The FS has experienced field problems with the Pathlink aircraft guidance and tracking system. The committee recommends that there be no further use of Pathlink until an engineering evaluation is made to determine its capabilities and limitations, and its relationship to GPS and GIS; and that MTDC be requested

to do this work. WO-FPM will send a letter to Director, Engineering requesting an engineering evaluation of Pathlink and investigate if other systems exist.

MTDC

4. **Evaluate the utility of the computer model Computer Assisted Spray Productivity Routine (CASPR) on a pilot or operational project.**

   CASPR is a model that calculates the productivity of spray aircraft. Input variables include aircraft speed, turn times, load capacity, swath widths, etc. The model has potential to reduce application costs through more knowledge and better estimates during negotiated contracts, and selecting optimum types of aircraft for projects. The committee recommends that CASPR be evaluated to assess its precision on a pilot in planning an operational project with MTDC taking the lead.

   MTDC

5. **Update reference reports on atomization of current pesticide tank mixes.**

   WO-FPM (Davis) has sponsored numerous wind tunnel tests at University of California, Davis Campus, to characterize the number and size of drops that are atomized from a variety of nozzles. Variables included tank mix, flow rate, atomizer, atomizer orientation, and air speed. Atomization data are used to select the proper spray parameters to support effective treatment. Data are scattered in several reports and are needed for several new tank mixes. Such data should be gathered and bound in one or two references. Further, an inventory should be taken to identify those tank mixes which need to be checked for atomization. Concurrent with wind tunnel tests is the need to determine physical properties of the tank mix.

   WO/FPM

6. **Update and add spray nozzle specification data to the Program WIND aerial application equipment handbook.**

   This Program WIND publication is being used nationally by Federal and State agencies. The committee recommends that the reference be enhanced with the addition of spray nozzle specifications. MTDC should include this when the handbook is revised.

   MTDC

7. **Coordinate complex terrain modeling with Global Positioning System (GPS), GIS, and expert system activities being developed by the FS.**

WO-FPM (Davis) and MTDC are pursuing the identification and incorporation of a suitable complex terrain code in the FSCBG model. A meeting is scheduled at WO-FPM, MAG during December, 1989 to discuss coordination and cooperation. The committee encourages close coordination with the FPM Advanced Technology Task Force and WO-CS&T.

MTDC

8. **Determine physical properties and drag coefficients of substances.**

The FS has need to aerially apply solid forms of pesticides, pheromones, seeds, and fertilizers. To predict distribution of these substances it is important to know the drag coefficients and physical properties of the particles. As substances are being considered for field use, MTDC should be contacted for these physical measurements.

MTDC

E. Information Management

1. **Plan and conduct multi-year monitoring, analyses, and data management of spray treatments.**

Even short term benefits of treatment cannot be determined during the first year of treatment. For cost/benefit information and other economic analysis, the benefits or lack of benefits over 3 to 5 year periods should be established and recorded. This includes the R-6 Meacham Pilot Project conducted in 1988. Monitoring during 1989 shows that the benefits of treatment were carried over from 1988 to 1989. Monitoring the R-3 Jemez Mountain control project showed that the western spruce budworm was kept suppressed for 5 years. This is valuable information in developing control strategies and in calculating cost/benefits for future control operations.

WO/FPM

2. **Publish a reference and maintain a Data General computer data base on western defoliator aerial spray projects.**

Julie Weatherby has prepared an outline for collecting and indexing basic data on aerial spray projects. The committee recommends that data be collected from projects dating back to 1970, be indexed, and added to the FS's national data base, searchable by index number, and also that it be published. The committee will send a letter to Regions 1, 2, 3, 4, 5, 6, and 10 and PSW, PNW, INT, and RM requesting their cooperation in providing references and/or base data. The committee members volunteered to assist in this endeavor. WO-FPM (Davis) will take the lead with a draft report ready by August 1990.

WO/FPM

F. Administrative

1. **Committee Operating Guidelines.**

   a. Emphasize cooperation between FIDR and FPM especially in planning and conducting field projects.

   b. Continue to emphasize the need to field test new strains of B.t. and not the HD-1 strain. The HD-1 strain has been adequately tested by FIDR, however, unique or unusual changes to HD-1 or its carrier may qualify it for testing.

   c. Maintain the traditional approach to field testing and pilot projects.

   d. Maintain this Steering Committee.

   e. Encourage thorough and timely reporting of field tests and pilot project results.

   f. Facilitate cooperation with industry and encourage development and testing of microbials.

   g. Seek ways to reduce costs of field tests and pilot projects, and to encourage industry to share costs.

2. **Guidelines for Field Tests and Pilot Projects.**

   a. Drafts of the Field Test and Pilot Project guidelines have been submitted to WO and are available for review by State cooperators and industry. FIDR has not yet decided whether to incorporate the Field Test guidelines in the FS handbook. FPM will incorporate the latest version of the Pilot Project guidelines in the FS handbook when the handbook is ready for publication. Both guidelines will continue as drafts for the foreseeable future.

   b. Need for other guidelines was discussed and the committee suggests that guidelines be written for conduct of airport spray characterization trials.

3. **Environmental Impact Statement for DFTM.**

   The committee recommends that a west-wide programmatic EIS be prepared for DFTM management.

4. **NOVO's Foray 48B, Bacillus thuringiensis.**

   The committee encourages NOVO to pursue a pilot project of Foray 48B following recommended guidelines.

5. **Microbial research.**

The committee recommends maintaining and increasing support of microbial and pheromone research for improved pest monitoring and suppression research.

6. **Joint Meeting of Western and Gypsy Moth and Other Eastern Defoliators Steering Committees.**

The eastern committee has suggested that the two steering committees meet jointly and the committee concurs. It is proposed that the committees meet during October 1990 at a mutually agreed to city (eg., Atlanta, Seattle, Salt Lake City, Denver, St. Louis, Pittsburg, or Kansas City). The respective committees would meet concurrently followed by a joint one day session.

7. **B.t. products.**

Currently registered B.t. products for Douglas-fir tussock moth and western spruce budworm, and their respective undiluted application rates for 16 BIU's per acre are listed below.

Product	Application Rate	Registration DFTM[1.]	WSBW[2.]
Thuricide 32LV	64 oz	X	X
Thuricide 48LV	43 oz	X	X
SAN 415	64 oz	X[3.]	X[3.]
Dipel 6L	43 oz	X	X
Dipel 8L	32 oz	X	X
Dipel 6AF	43 oz	X[3.]	X[3.]
Dipel 8AF	32 oz	X[3.]	X[3.]
Foray 48B	43 oz	X[3.]	X[3.]

1. DFTM = Douglas-fir tussock moth.
2. WSBW = Western spruce budworm
3. Not registered for forestry use in California.

8. **Acephate (Orthene).**

The committee recommends that WO-FPM investigate opportunities to seek re-registration of acephate for control of forest defoliators.

III. ACCOMPLISHMENTS

Summarized below are accomplishments related to 1988 committee recommendations.

A. Laboratory and Field Experiment Testing

1. Ecogen, Condof, (HD-269) Bacillus thuringiensis (B.t.) was field tested.

2. New strains of B.t. were screened on an on-going basis.

B. Pilot Project Testing

Novo, Foray 48B (HD-1) B.t. was pilot tested.

C. Other

1. Incident Command Systems (ICS) system has been incorporated in current draft revision of FSH 2109.11, chapter 3.

2. WO-FPM in cooperation with FIDR has met with EPA concerning need to ease rules on registration of pheromones and issuance of experimental use permits.

3. There is increased cooperation and interacting among FIDR and FPM scientists.

4. Cooperative field projects were conducted by FIDR and FPM.

5. Traditional approach to field testing and pilot projects is being supported and maintained.

6. Steering committee is being maintained.

7. Guidelines for conduct of field tests and pilot projects have been drafted, reviewed, and submitted to Director, WO/FPM.

8. Preliminary procedure for accessing and summarizing a data-base of past spray projects has been developed.

9. Field training for use of aerial spray models has been accelerated with several hands-on workshops conducted and five other workshops scheduled over the next four months. FSCBG model was run in support of control projects in R-1, R-4, and R-5.

D. Reports

Project reports are enclosed in Appendix B.

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Western Defoliators met in Albuquerque, October 11-12, 1989, to review events since the 1988 meeting, and to identify testing and related needs. The steering committee is evolving from its initial role of evaluating pilot project testing needs to that of identifying needs and recommending laboratory, developmental, field testing and pilot projects of pesticides, equipment, and strategies. The committee established operating guidelines at this meeting and prepared a listing of recommendations subdivided into six categories. The committee emphasizes that to address the needs and recommendations stated herein there is need for continued close cooperation among FPM, PNW, and PSW scientists; and for continuous of the PNW pesticide and microbial laboratories.

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APPENDIX A
Committee Operating Guidelines

OPERATING GUIDELINES
FOR
NATIONAL STEERING COMMITTEES
CONSIDERING
FIELD TESTS AND PILOT PROJECTS
FOR THE
AERIAL APPLICATION OF PESTICIDES

MEMBERSHIP: Committees members should be nationally recognized research, developmental, and applied scientists as well as natural resource professionals drawn for the most part from the Forest Service but also from other Federal and State agencies.

PURPOSE: The committees' primary tasks are to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperators ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

PROCEDURES:

The committees shall:

- meet at least annually, preferably during late summer or early fall so recommended projects can be considered for approval, funding, and implementation the next field season.

- focus on sound science that may lead to improving pesticide application consistent with its stated purpose.

- assign priorities to testing needs agreed to by the committee.

- review data and progress of field and pilot tests.

- suggest who might conduct future tests and where the tests might be conducted.

- take action to address needs such as development of guidelines for field test and pilot projects, database formats, and literature studies.

- establish sub-committees to pursue single issues such as review of laboratory and field test data.

The members shall:

- determine pesticide application needs within their geographical, administrative or organizational area prior to each meeting.

- be cognizant of all appropriate Region/Area/Station/State/cooperator needs.

- bring to the meeting needs that have been discussed with line officers and staff.

- represent the unit's needs within the national perspective of the committee.

The Director FPM/WO shall:

- coordinate the report recommendations within WO, and with the Regions, NA, and Stations as appropriate.

- review the steering committee recommendations and resultant FPM project proposals for funding.

- give strong consideration to the steering committees recommendations in prioritizing project proposals for funding.

- complete project approval and funding by January for projects funded by FPM.

AERIAL APPLICATION OF PESTICIDES
WESTERN DEFOLIATORS STEERING COMMITTEE

Project Report For Region 3
October 11-12, 1989

Western Spruce Budworm (WSB) decreased significantly in its activity throughout Region 3. Forest defoliation caused by this insect decreased from 195,700 hectares in 1988 to 36,750 hectares in 1989.

No aerial suppression projects were conducted in the region in 1989; however, ground application of Bacillus thuringiensis (B.t.) wwere undertaken to protect foliage from WSB defoliation. In the Camino Real RD of the Carson National Forest, thirteen (13) campgrounds were treated with Thuricide 32LV and an adjuvant (Stick). The treated campgrounds encompassed a total area of approximately 31.2 hectares and were treated during the week of June 5 when the majority of the buds in Douglas-fir were fully flushed and budworm larvae were in the 3rd and 4th instar.

Applications were made using a ground hydrolyic sprayer made by Thorco Master Sprayers. The biological insecticide was applied to the foliage at a dosage rate of 1/2 gallon (16 BIU's) per 100 gallons of solution. A sticker (Stick) was added to the tank mix at a rate of one (1) pint per 100 gallons of mix.

Post treatment ofservations indicated foliage was protected and visual quality maintained by treatment.

APPENDIX B
R-4

10/11/89

National Steering Committee, Aerial Application of Pesticides - Western Defoliators

Project Report for R4

Gypsy Moth Eradication Project - Salt Lake City, Utah

Site: Salt Lake City - 1200 Ac in the Olympus Cove area

Applications: 3 applications of Dipel 8L

Application Aircraft: Jet Ranger 206 B3

Spray System: Simplex pump, Beecomists

Results: Significant population reductions have occurred in most areas within spray block. One area within the heavily infested core was evidently skipped. Perimeter apparently didn't receive adequate coverage.

Plans for 1990 project: The project area will probably increase to at least 20,000 ac. The area sprayed in 1989 will be included in the spray blocks designated for 1990. In addition areas near Bountiful and Provo will be treated.

In 1987 about 7,000 acres on the Plumas NF, Lassen NF and intermingled private lands were defoliated with DFTM . After evaluating the outbreak and treatment alternatives, the Plumas Forest Supervisor decided to conduct a field/pilot test using Bacillus Thuringiensis (BT). At the time of the decision BT was only registered at 8 BIU/acre for DFTM. The test compared the efficacy of an 16 BIU/acre doses applied at either 128 oz/acre or 64 oz/acre. Each treatment was replicated four times with 5200 areas being treated. An AT-301 Air Tractor was used to make the applications using six Microaire AU 500 rotary nozzles. Population reductions are summarized in Table 1.

In the fall of 1988 an addition 80-90,000 acres were found to be infested with DFTM. The results of the NEPA analysis led to the decision to treat the outbreak with 16 BIU of BT (Thuricide 32 LV, the only formulation registered at that dose in CA at the time of the decision). The objective of the operational project was to reduced tree mortality by reducing the DFTM population by 80%. Because of the results from the prior field/pilot test we prescribed treating the population at 50% dispersal instead of waiting for 10 days after hatch and dispersal (the old application timeing). Application was made with eight Turbo Air Tractors equiped with 8010 flat-fan nozzles. Applications rate was 128 oz/acre with an atomization of 162 to 190 microns. Population reductions are summarized in Table 2. The early application provided substantial foliage retention. We estimate that we protected 50% of the new foliage on the majority of the 83,871 acres treated.

Table 1.

[a] COMPARISON OF DFTM POPULATION REDUCTION AFTER TREATMENT WITH 16 BIU OF BACILLUS THURINGIENSIS AT 128 OZ/AC VERSUS 64 OZ/AC-PLUMAS NF, 1988.

TREATMENT (oz/ac)	LARVAL DENSITY[a] PRESPRAY	PERCENT REDUCTION
128	452.5	92.5
64	558.4	88.6
CONTROL	467.1	78.2

[a]NUMBER OF LARVAE PER 1000 SQ. IN. OF FOLIAGE

Table 2.

DFTM POPULATION REDUCTION - LASSEN/PLUMAS DFTM PROJECT, 1989

UNIT	LARVAL DENSITY PRESPRAY	PERCENT REDUCTION
PLUMAS	200.7	88.4
LASSEN	203.4	90.1

MESSAGE SCAN

'o I.RACENOVICH
:C J.BARRY:SCS06

'rom: James S. Hadfield:R06A
'ostmark: Sep 29,89 7:52 AM Delivered: Sep 29,89 7:54 AM
;tatus: Previously read
;ubject: WESTERN DEFOLIATORS

:omments:
IRAL, I HAVE BEEN ACCUMULATINC SUCCESTIONS FOR AERIAL APPLICATION OF
'ESTICIDES-WESTERN DEFOLIATORS STEERING COMMITTEE. HERE THEY ARE.

-------========X===============

STEERING COMMITTEE, AERIAL APPLICATION OF PESTICIDES, WESTERN DEFOLIATORS

These are suggestions and thoughts I offer up to you for consideration by the Aerial Application of Pesticides, Western Forest Defoliator Steering Committee at the October meeting in Albuqueque.

Pilot Tests-- Based upon my recent personal experience,decisions to do pilot tests should, at a minimum, be made while the candidate sites are accessible and while there is some reasonably observable evidence of the target insect populations present. This means early summer for the most part. In my opinion pilot tests should be planned at least 1.5. years ahead of their execution so ample time is available to find suitable sites, which means accessible terrain and a healthy insect population.

I feel the only product that should be pilot tested for western spruce budworm control is SAN 415 SC produced by Sandoz. It should be tested at 16 BIU applied undiluted at 64 ounces per acre.

We seem to have informally settled on Thuricide 32 LV as a standard that we compare other BT products to. If there are more pilot tests, I reccomend that Thuricide 32 LV, applied undiluted at 16 BIU in 64 ounces per acre, be included as a treatment so we can, in fact, compare other treatments to it.

Do not pilot test Dipel 8L or any BT product at rates less than 43 ounces per acre. The reason is these low volume applications seem to have a high potential for failure. Sometimes they work. Sometimes is not good enough. Let Abbott Labs test Dipel 8L at low volumes.

I am of the opinion that we could probably do away with pilot tests and go directly from a well designed field test to operational use of a product. I feel the only potential advantage offered by a pilot test compared to a field test is the opportunity to observe handling features of the product applied to a large acreage. This advantage can be largely offset by having 4 to 5 replicated blocks of about 50 acres, each treated on separate days. Applications could also be applied to some of the blocks under less than optimum conditions to simulate conditions likely to be experienced in operational projects. A field test may cost about $100,000, a pilot test is likely to cost $500,000. I do not believe the extra $400,000 is worth it.

The Forest Service should encourage BT producers to do field tests on their own. We need to help them by making sites available, and possibly some equipment. Another prospect is to contract pilot and field tests with private companies. We could conceivably get caught up in an endless series of tests because the producers are continuing to modify existing products and develop new ones. Time to break new ground.

Field Tests-- Do not test any Ecogen product in the field. Let Ecogen test on their own.

Do field tests of TM Biocontrol-1 at doses lower than that presently recommended for control of DFTM.

Do a field test of BT (maybe Thuricide 32LV or Dipel 6L) against suboutbreak populations of DFTM to determine if outbreaks can be prevented or if spot treatments can be effective.

Do a field test of TM Biocontrol-1 against suboutbreak populations of DFTM to determine if outbreaks can be prevented or if spot treatments can be effective.

Other Tests--There is a need to test application and monitoring procedures so that the most efficient and effective approaches are being used to apply insecticides.

Guidance systems that allow application pilots to accurately determine their location and place their swaths without close monitoring by observation helicopters carrying government inspectors has the potential for reducing the cost of application. Pathlink has not worked satisfactorily in past test efforts. Available technology should be evaluated and modified as approppriate to fit forestry applications.

Aerial observation of spray aircraft from helicopters should be compared to that from airplanes. Thoroughness of coverage of the target areas with insecticides, amount of misapplication (double coverage, spraying outside blocks), and cost of observation should be compared.

We need procedures for testing the potency of BT products after they have been produced by the manufacturer but before the Forest Service applies them in the forest. In other words let's make sure the stuff is viable before it is sprayed.

There is still a need for some form of spray deposit assessment. I would like to have the Kromekote twigs used in eastern Canada tested as a collection device in comparison to flat Kromekote cards placed on the ground.

This falls in the area of research. There is a need to develop or test carriers for TM Biocontrol-1. The existing procedure has a high potential for causing logistical problems if large acreages would need to be sprayed. We would like to be able to apply TM Biocontrol-1 at 64 ounces per acre.

The CASPR model should be field tested to determine if it can be used to help design application projects or if modifications are needed.

Consider doing further field validation of AGDISP and FSCBG by comparing the predictions to actual measurements collected on an operational project, such as the potential WSBW project at Yakima Indian Reservation.

Test the "Twardus" application monitoring system on western defoliator suppression projects to determine its applicability and/or need for modifications.

1989 WESTERN SPRUCE BUDWORM PILOT TEST, HALFWAY, OREGON, WALLOWA-WHITMAN NATIONAL FOREST. PACIFIC NORTHWEST REGION

LOCATION: Pine, LaGrande Ranger Districts and Hells Canyon National Recreation Area, Wallowa-Whitman National Forest, Oregon.

INSECTICIDE: Foray 48B. Treatment # 1. Foray 48B applied undiluted at the rate of 16 BIU in 42.7 ounces per acre. Treatment # 2. Foray 48B applied diluted with inactivated Foray 48B at the rate of 16 BIU in 64 ounces per acre.

APPLICATION: Hiller-Såloy 12Es equipped with 6 Beecomist 360A atomizers. Contractor, Western Helicopter Services, Newberg, Oregon.

TEST ACRES: 7,200. Acres sprayed 5129.

COST: $500,000

TEST DESIGN: Three treatments, Foray @ 1/3 gallon/acre, Foray @ 1/2 gallon/acre, and no spray. Each treatment was replicated four times. A complete set of treatments was applied each treatment day. Treatments were assigned at random to test blocks.

DISCUSSION: The purposes of the pilot test were to determine if the insecticide treatments could reduce the WSBW population to 1 or less insects per sample branch and to compare the two volumes of 1/3 to 1/2 gallons per acre. Test blocks had to have WSBW early larval densities of at least 12 with 90% confidence levels to qualify. A total of 12 test blocks, averaging 500 acres each were used. Prespray populations measured 1 day before spraying were high, averaging 24.5 WSBW per sample branch. Post-spray density averaged 4.8, 3.5, and 13.5 for the 1/3 gallon, 1/2 gallon, and 0 gallon applications, respectively. Budworm mortality, uncorrected for natural mortality, averaged 82, 85, and 44 percent for the 1/3 gallon, 1/2 gallon, and 0 gallon applications, respectively. Post-spray densities are statistically different between the treated blocks and the control blocks, but not between the two volumes. Spray deposition was rated good to excellent for the treatments. There were no handling problems with the Foray. The application contractor remarked that Foray was the easiest handling BT product he had ever used.

Other "new" approaches were used on the Halfway pilot test. Practically all supplies and equipment, other than that provided by the application contractor, were ordered from the Redmond Air Center using the ICS resource ordering system. This approach was highly successful.The contract required the applicator to use his personnel to mark the spray blocks, rather than have Forest Service employees do it. This also worked well, but the contract language needs to be improved to reduce potential for misinterpretations. Another approach new to R-6 involved placement of fluorescent panels on the ground by Forest Service employees laying out test blocks. This aided the contractor in his marking.

1989 WESTERN SPRUCE BUDWORM SUPPRESSION PROJECT, HIGH ROCKS,MT HOOD NATIONAL FOREST.

LOCATION: Clackamas Ranger District, Mt Hood National Forest, Oregon.

INSECTICIDE: Dipel 6L applied undiluted at the rate of 16 BIU in 42.7 ounces per acre.

APPLICATION: Bell 47G equipped with 6 Beecomist 360A atomizers. Contractor, Ptarmigan Helicopters, Evergreen, Colorado.

ACRES TREATED: 7454

COST: $155,000

DISCUSSION: The High Rocks operational project was carried out in June and July. The project area is located in the high Cascades, and was characterized by steep terrain with many aspects. The project area was divided into 20 separate spray blocks because of the terrain. The early larval density average for all 20 blocks was 15.2 WSBW per sample branch, with a range of 1.3 to 38.0. Spraying began on June 21 and ended on July 7. Spraying occurred on 9 days. The post-treatment density measured 14-to-21 days after application averaged 5.5 WSBW per sample branch. The target of the project was to reduce the WSBW population to 1 or less. The reasons for the disappointing population reduction are not known. The project area and surrounding stands sustained moderate to severe defoliation.

1989 HIGH ROCK PROJECT
DATA SUMMARY

BLOCK NUMBER	NUMBER OF PLOTS	DATE EDENS	MEAN EDENS	DATE LAST DEVELOP	PERCENT L2 & L3	PERCENT UNFURLED	DATE RELEASED	DATE SPRAYED	DATE POSTDENS	MEAN POSTDENS
1	3	6/8/89	5.3	6/24/89	0.0	97.3	6/24/89	6/26,27/89	7/10/89	1.7
2	3	6/6/89	8.0	6/24/89	1.6	78.9	6/26/89	6/27/89	7/11/89	7.0
3	3	6/9/89	10.3	6/24/89	2.0	85.5	6/24/89	6/27/89	7/14/89	3.7
4	3	6/11/89	9.0	7/5/89	0.0	99.1	7/6/89	7/7/89	7/27/89	2.7
5	3	6/8/89	17.7	7/1/89	10.1	84.7	6/29/89	7/5/89	7/19/89	7.0
6	4	6/11/89	26.7	7/1/89	0.8	74.9	6/29/89	7/2/89	7/21/89	10.7
7	5	6/6,8,9/89	12.8	6/28/89	2.1	98.2	6/29/89	7/1/89	7/18/19/89	5.1
8	3	6/5,11/89	2.2	6/20/89	0.0	85.9	6/17/89	6/21/89	7/12/89	0.2
9	3	6/11/89	26.0	6/29/89	1.6	71.4	6/29/89	7/1,2/89	7/20/89	13.0
10	3	6/9/89	5.3	6/29/89	0.8	95.2	6/17/89	7/1/89	7/18/89	4.7
11	3	6/9/89	25.0	6/27/89	0.0	90.2	6/27/89	6/28/89	7/12/89	5.3
12	3	6/8,11/89	11.0	7/5/89	1.3	90.7	7/6/89	7/7/89	7/27/89	2.8
13	3	6/7/89	14.0	6/27/89	0.0	96.4	6/27/89	6/28/89	7/19/89	1.0
14	3	6/7/89	32.0	6/29/89	3.4	83.7	6/29/89	7/1/89	7/15/89	5.7
15	3	6/9/89	1.3	6/24/89	0.0	91.8	6/24/89	6/26/89	7/11/89	0.7
16	1	6/12/89	25.7	6/27/89	0.0	92.4	6/26/89	6/27/89	*	*
17	3	6/7/89	38.0	7/1/89	1.9	86.2	6/29/89	7/2/89	7/24/89	14.3
18	4	6/9,11/89	23.5	7/3/89	2.5	98.6	6/19/89	7/6/89	7/27/89	4.7
19	3	6/7/89	15.3	7/2/89	3.4	96.5	7/2/89	7/5/89	7/19/89	15.3
20	2	6/12/89	19.3	6/27/89	**	**	7/2/89	7/5/89	7/26/89	11.7
TOTAL	61	------	15.2	-------	---	---	------	------	-------	5.5

* Plot outside of spray area, no post-treatment sample taken.

** Due to inaccessibility, release based on Block 19 development data.

1989 Western Spruce Budworm Suppression Project, Boise Cascade, Simcoe, Washington

Location: Boise Cascade, Simcoe Pass, Washington

Insecticide: Sevin 4-Oil (carbaryl) 1 lb. a.i. per acre

Application: Hiller Soloy, Western Helicopters, Newberg, Oregon

Acres Treated: 1,500

Discussion: Two blocks totaling 1,500 acres were treated on Boise Cascade land with carbaryl. The two blocks were 380 acres and 1,120 acres in size and were located 8 miles apart. Entomological information was collected by the Washington Dept. of Natural Resources. Limited manpower resulted in a minimum number of samples per spray block. The sampling design for each block consisted of three sample plots per block, two sample trees per plot, and two branches per tree. An early larval density was taken on May 26, the prespray sample was taken on June 15, and the postspray sample was taken 14 days after treatment, on June 29. The following is a summary of the project results. Larval densities are numbers of larvae per 45 cm branch tip.

Block	Acres	Early Density	Prespray	Postspray
Pipeline	380	40 ± 14	33 ± 18	0
Devil's Canyon	1,120	41 ± 19	27 ± 14	.06 ± .2

No check plots were taken, however, a walk through of areas adjacent to the treated areas at the time of the postspray sample showed active larval feeding and sixth instar larvae spinning from webs.

1988 Meacham Pilot Project, Umatilla National Forest, Oregon
One Year Post Treatment Sampling

Location: Umatilla National Forest, Oregon

Treatments: Dipel 6AF at 42.7 oz/ac undiluted;
Thuricide 48LV at 42.7oz/ac undiluted
Check

Discussion: In 1988, the Meacham Pilot Project was conducted. The Pilot Project consisted of 3 replicates each of two B.t. products and the check. The sample design consisted of 25 sample plots per treatment block, with three sample trees per plot. The purpose of the 1989 sampling was to quantify the short-term effects of the treatments on western spruce budworm population reduction and defoliation, by measuring the 1989 budworm population densities and defoliation. The 1989 measurements were taken at approximately the same time as the 1988 post-treatment samples were taken, at the start of pupation on the blocks. Sampling was done in the same manner as the post-treatment sampling: that is, four 45 cm. branches were taken from the midcrown of each sample tree. Samples were processed in the field, and total counts of budworm were made, including larvae, pupae, and pupal exuviae. An estimate of defoliation was made using the six-class system.

Data are currently being analyzed by MAG biometricians. Not all information is available at this time, however, the following table shows 1988 pre-treatment and post-treatment densities, and the preliminary 1989 one year post-treatment densities.

1988 Meacham Pilot Project Pre- and Post- Treatment Densities and 1989 One Year Post-Treatment Densities

(Budworm per 45 cm. branch)
(mean ± SE)

Block	1988 Pre-Spray	1988 Post-Spray	1989 Post-Spray
4D	19.6 ± 1.9	3.5 ± 0.5	1.4
5T	20.6 ± 1.0	1.6 ± 0.4	0.2
6C	23.2 ± 2.5	9.6 ± 1.0	5.4
7C	17.2 ± 1.1	8.6 ± 0.8	4.3
8T	18.0 ± 1.6	0.7 ± 0.1	0.7
9D	18.0 ± 1.1	2.1 ± 0.4	3.1
10D	15.8 ± 1.2	0.9 ± 0.2	0.9
12T	19.4 ± 2.0	0.8 ± 0.2	2.5
13C	11.6 ± 0.9	5.6 ± 0.4	3.3

post-treatment densities are unadjusted for mortality

Treatment Summary

Treatment	1988 Pre-Spray (mean ± SE)	1988 Post-Spray (mean ± SE)	1989 Post-Spray
Dipel 6AF	17.8 ± 0.9	2.17 ± 0.2	1.8
Thuricide 48LV	19.3 ± 0.9	1.0 ± 0.2	1.1
Check	17.3 ± 1.1	7.9 ± 0.5	4.3

APPENDIX B
PNW

1989 WESTERN SPRUCE BUDWORM FIELD TEST OF CONDOR AF AT ENTERPRISE, OREGON

Location: Wallowa Valley Ranger District, Wallowa-Whitman National Forest, Oregon. Project site north-northwest of Enterprise, Oregon.

Insecticide: CONDOR AF applied at three dosages using a constant spray application volume.

Application: Bell 47 helicopter equipped with 6 Beecomist 360A Rotary Atomizers on a standard spray boom. Contractor, Western Helicopter Services, Newberg, Oregon.

Test Acreage: 320 hectares (240 treated + 80 untreated checks).

Test Design: Randomized Block Design. Five blocks containing four 16-ha plots each. Within each block, the treatments and untreated checks were ranomly assigned to the plots; therefore, each treatment was replicated five times. A single block was treated each day with the order of plot treatment randomly assigned.

Pre- and postspray population sampling was conducted on 30 trees per plot using a single 45 cm midcrown branch per tree. In addition, foliage bioassays were collected at 0-hour, 1-, 5-, 10-, and 20-days to determine persistance of the Bt.

Discussion: Logistically, the spray operation went exceptionally well; spraying began on June 17 and was completed on June 24 with a 3-day layoff between blocks 2 and 3 because of cool, inclement weather. The larval populations were predominately 4th and 5th instars at the time of spray application. The use of balloons and large orange panels on the plot corners, and the experience of the pilot ensured that the spray reached the proper target as verified by ground observers.

The population sampling showed that there was no significant difference between any of the treatments and the untreated checks (Attachment I). The 0-hour bioassay also showed poor kill; normally, one would expect >90% kill when the foliage is collected immediately after spraying and forced upon laboratory insects. We tested the tank water against distilled water in our Corvallis laboratory to determine if the water was responsible for deactivation of the Bt. We used Thuricide 32LV, Foray, and Condor during the test. The laboratory results (Attachment II) showed that the field results were not due to the water source.

Boom samples were collected after each spray operation and tested using a diet incorporation technique. Preliminary results show that the material introduced into the diet at the rate of 10 ug per ml of diet will kill the test insects; the next step is to produce LD_{50} curves through a dilution process of each test material. Lloyd Browne, Ecogen representative, was on site at the heliport during the first day of spraying. During subsequent discussions with him about the results, he mentioned the possibility that the sticker may have encapsulated the active Bt by drying during the fine-droplet settling to the target under our field conditions. Both Ecogen and PNW are trying to resolve the problem that occurred in the 1989 test.

Attachment I

Pre and Postspray Sampling of Western Spruce Budworm
Condor AF Test, Enterprise, OR, 1989

Treatment	Plot	Mean #Insects per Branch	
		Prespray	Postspray
16 BIU	1	12.4	7.3
	8	17.3	9.3
	11	18.0	9.4
	16	18.0	7.7
	19	21.4	4.8
Mean		17.42	7.70
8 BIU	2	18.4	12.9
	6	20.5	9.3
	9	16.7	8.6
	13	14.4	4.4
	18	18.2	11.2
Mean		17.64	9.28
4 BIU	3	13.9	7.0
	5	17.9	11.1
	10	22.3	7.0
	15	19.7	6.4
	20	22.1	8.7
Mean		19.18	8.04
Check	4	15.1	7.3
	7	9.5	5.9
	12	20.5	12.7
	14	20.3	6.9
	17	23.8	6.9
Mean		17.84	7.94

Attachment II

WATER TEST TO DETERMINE EFFECT ON Bt

Treatment	Water Source[1]	Replication	# Dead	Percent Bt Killed[2]
Thuricide	Distilled	1	22	100
		2	24	100
	Tank	1	24	100
		2	23	100
Novo	Distilled	1	24	100
		2	21	100
	Tank	1	25	100
		2	24	100
CONDOR OF	Distilled	1	20	100
		2	19	100
	Tank	1	24	100
		2	18	100

[1]Distilled water from Corvallis Laboratory; Tank water obtained from the water truck used on the 1989 spray test.

[2]Based on 10 randomly chosen dead larvae in each replication of 25 insects. Bt verification by use of a compound microscope with phase illumination.

APPENDIX C
Guidelines - Field Experiments
and Pilot Projects

RECOMMENDED GUIDELINES FOR
DESIGN OF PILOT PROJECTS -
AERIAL APPLICATION OF PESTICIDES
(**DRAFT**)
8-31-89

I. INTRODUCTION

A. General

The USDA Forest Service (FS) conducts pilot projects to evaluate operational use of pesticides, application systems, and strategies to manage forest pests. Decisions to proceed with a pilot project are based upon current or projected needs of the FS and availability of research data to support the new technology. Pesticides, application systems, and strategies customarily are researched or developed through the field testing stage, by the FS, other agencies, universities, or the private sector prior to being evaluated on a pilot project. Occasionally circumstances may dictate that a pesticide, application system, or strategy be pilot tested prior to completing research and development. In such cases the test may be a cooperative field and pilot project, with characteristics of both types of testing, but with major emphasis on an operational-scale variable. Pilot project design and conduct will vary depending upon test objective, criteria, and evaluation criteria e.g., evaluating biological effectiveness vs evaluating engineering performance of a spray system.

B. Purpose

The purpose of this document is to set forth a set of broad guidelines for planning and conducting pilot projects involving aerial application of pesticides, application systems, and strategies. Persons intending to conduct pilot projects are encouraged to follow these guidelines.

C. Background

The agency (FS or State cooperator) intending to use the pesticide, application system, or strategy operationally usually will participate in conducting the pilot project. In the process of conducting the pilot project the agency prepares for operational deployment of the pesticide, application system, or strategy. Thus, the agency determines during the pilot project whether it can use the pesticide, application system, or strategy effectively under operational conditions. To this end objectives might not be met if the pilot project were contracted to a non-agency entity. There are, however, special circumstances when a contractor might be appropriately contracted to conduct portions of a pilot project, e.g., weather monitoring, biological or spray deposit sampling, or laboratory assessment activities.

D. Scope

The scope of this document covers pilot projects to evaluate the operational use of aerial application of pesticides, application systems, and strategies. The guidelines are oriented toward pesticide application projects; however, they are also applicable to pilot project evaluation of equipment and strategies. These guidelines are for use by public agencies and the private sector.

E. Definitions

Administrative Project (Study) - A special project conducted for a special local need of a District or Forest. The project may or may not include an accepted statistical design.

Application Systems - Spray application equipment that may include 2 or more of the following: aircraft, nozzles, aircraft guidance system, spray monitoring equipment, and other new eqiupment.

Control (Checks) - A series of experimental units (i.e., plots) receiving no treatment and/or a standard treatment; and included in the experiment or pilot project under the same conditions as the treatment.

Cooperative Field and Pilot Project - A field project conducted cooperatively by FIDR and FPM that meets objectives of both a field test and a pilot project, and that meets the statistical design criteria of a field test.

Demonstration - A special project to demonstrate effectiveness of a product, equipment, or strategy; with or without the benefit of an accepted statistical design.

Field Test - A research project designed to evaluate several treatment variables under field conditions.

Operational Projects - A full scale control project designed to utilize the best treatment materials, equipment, techniques, and strategies available to treat a forest pest problem.

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A project with an appropriate statistical design that simulates an operational-scale action, and considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy. More than one variable (e.g., pesticide), however, may be tested concurrently.

Randomization - The assignment of treatments to project units so that all units have an equal chance of being selected for treatment or as controls.

Replication - A treatment (including controls) which is repeated on two or more project units. Its function is to provide an estimate of natural variation and reduce confounding factors when measuring treatment effects.

Standard Treatment - A treatment using a product, equipment, or strategy for which the effectiveness is known or predictable.

Strategy - An approach to manage a forest pest that may include but not be limited to timing of treatment; size and frequency of treatment; combination of control methods; and other proven and unproven approaches.

II. GUIDELINES

A. Work Plan

A work plan should be prepared by the performing agency and coordinated with interested parties. The plan should include the who, why, what, when, where, and how of the project. The objective, methods, and analyses should be clearly stated and described. Work plans should also include operational aspects to include schedule of events, responsibilities, health and safety, and background information on the items being tested (e.g., pesticide labels, material safety data sheets, and equipment specifications). As a guideline, the work plan should include sufficient detail to allow another person or group to conduct the pilot project. The pilot project design should include data collection and analyses that collectively might explain failures and successes.

A typical work plan, therefore, should include the following sections:

1. Introduction and Background
2. Objectives and Tasks
3. Project Area Description Physical and Biological
4. Pesticide, Application System, or Strategy Description
5. Methods - Project Design
6. Pesticide and Equipment Handling Procedures
7. Field Sampling Procedures
8. Laboratory Procedures
9. Environmental Monitoring
10. Data Analysis
11. Administration, Organization, and Budget
12. Safety
13. Public Involvement
14. Reporting Results and Technology Transfer

B. Criteria for Selecting Treatment Block

Criteria for selecting treatment blocks for pilot projects will vary depending upon objectives, available areas, environmental concerns, and other practical considerations. Most pilot projects will require

[illegible] (including controls) which is measured in [illegible] its function is to provide an estimate of [illegible] a confounding factor when the various [illegible]

[illegible] but using a product, equipment, or [illegible] effect(s) is known or predicted to [illegible]

Strategy - An approach to manage a pest [illegible] the way insects may be [illegible] limited to timing of treatments, size and frequency of treatment, combination of control methods, and other proven and unproven approaches.

II. GUIDELINES

A. Work Plan

A work plan should be prepared by the performing agency and coordinated with interested parties. The plan should include the who, what, when, where, and how of the project. The objectives, methods and analyses should be clearly stated and described. Work plans should also include operational aspects to include schedule of [illegible] responsibilities, health and safety, and background information on items being tested (e.g., pesticide labels, potential safety data sheets, and equipment specifications). As a guideline, the work plan should include sufficient detail to allow another person to conduct the pilot project. The pilot project design should include data collection and analyses that collectively might explain increases and decreases.

A typical work plan, therefore, should include the following sections:

1. Introduction and Background
2. Objectives and Tasks
3. Project Area Description Physical and Biological
4. Pesticide, Application System, or Strategy Description
[illegible] Methods - Project Design
[illegible] Pesticide and Equipment Handling Procedures
[illegible] Sampling Procedures
[illegible]ed.

treatment replications and controls; therefore, blocks should be similar in size, elevation, exposure, stand composition, and in the case of pesticide application, the blocks should have comparable populations of pests. Control blocks should be located upwind of treatment blocks and at suitable distance to avoid spray drift. In addition they should be monitored for drift. Treatment blocks should be comparable in size to those that might be treated operationally. Size may range from a few acres (e.g., seed orchards and site preparation areas) to a few thousand acres (e.g., western spruce budworm control areas).

C. Criteria for Evaluation

A pilot project should have a sound rationale for its statistical design. For reasons discussed above the design will vary from project to project. It is suggested that the statistical design be reviewed by a statistician, by a research specialist, and by future users of the technology being tested. Design of pilot projects should include control (check) blocks and appropriate replication of the test treatment. In cases where replication or control blocks are not feasible, the pilot project objectives should be reviewed, and consideration given to conducting some alternative evaluation such as a special demonstration or an administrative project. When this is done it should be with the understanding that project results will not be as meaningful as those of a field test or pilot project with appropriate replications and checks.

Control and treatment blocks should be selected randomly from a group of blocks with similar characteristics. A minimum of three replications for both treatment and control blocks is recommended. All treatment blocks should be selected randomly for treatment, even recognizing that practical considerations may argue otherwise for treatment blocks, in particular. To select some blocks by other than a random approach, however, would be a serious departure from sound pilot testing in the sense that each area should have an equal opportunity to receive any treatment. To select by other criteria runs the risk of biasing test rationale and results of the evaluation.

D. Measurement of Biological Processes

The selection of appropriate sampling procedures to obtain statistically accurate estimates of population densities and, when necessary, to monitor population development, is essential for the successful completion of any pilot project. Sampling procedures should be described in detail in the work plan and final report. Population estimates obtained as a result of following the selected sampling procedure should be displayed with their attendant measures of variation (standard deviations, standard errors of the mean, etc.). At a minimum at least one pre-spray and one post-spray evaluation following the selected sampling procedures must be performed in both treated and untreated control blocks and the results reported. When treatment efficacy is affected by proper timing in relation to the

target pest population, pest and host phenology information, if known, describing the lifestage distribution of the population during treatment should be reported.

Most major target pests have published sampling procedures. Examples of publications dealing with sampling procedures for Douglas-fir tussock moth, western spruce budworm, and gypsy moth are listed below:

Douglas-fir tussock moth

Mason, R.R. 1970. Development of sampling methods for the Douglas-fir tussock moth, Hemerocampa pseudotsugata Lepidoptera: Lymantriidae). Can. Entomol. 102:836-45.

Mason, R.R. 1979. How to sample Douglas-fir tussock moth larvae. USDA Agricultural Handbook No. 547, 15 pp.

Mason, R.R.; Wickman, B.E.; Paul, H.G. 1989. Sampling western spruce budworm by counting larvae on lower crown branches. PNW-RN-486, 8pp.

Western spruce budworm

Carolin, V.M.; Coulter, W.K. 1972. Sampling populations of western spruce budworm and predicting defoliation on Douglas-fir in eastern Oregon. Res. Pap. PNW-149. Portland, OR, 38 pp.

Srivastava, N; Campbell, R.W.; Torgersen, T.R.; Beckwith, R.C. 1984. Sampling the western spruce budworm: fourth instar, pupae,and egg masses. Forest Science 30(4):883-892.

Gypsy moth

Wilson, R. W., Jr.; Fountaine, G. A. 1978. Gypsy moth egg-mass sampling with fixed and variable radius plots. USDA Agricultural Handbook No. 523, 46 pp.

Kolodny-Hirsch, D. 1986. Evaluation of methods for sampling gypsy moth egg mass populations and development of sequential sampling plans. Environ. Ent. 15:122-7.

Dubois, N.; Reardon, R.; Kolodny-Hirsch, D. 1988. Field efficacy of the NRD-12 strain of Bacillus thuringiensis against gypsy moth. J. Econ. Ent. 81:1672-1677.

Sampling procedures for some target pests may not be adequately addressed in published literature. In these cases procedures should be selected based on recommendations made by recognized specialists.

In addition to the sampling requirements detailed above, several other procedures may help a potential user interpret the results, and thus

improve the credibility and acceptance of pilot project results. Biological assays (tests of the performance of field applied pesticides in a controlled environment on susceptible lifestages of the target insect) help to ensure that reported differences between mortality rates in the treated and control blocks resulted from exposure to the pesticide. Measurement of the pesticide potency obtained by quantifying the amount of active ingredient in sub-samples of each field batch provides additional information on potential effectiveness of the pesticide. Implementing procedures within the pilot project to fill data gaps on the effects on non-target organisms are encouraged.

E. Measurement of Physical Processes

The physical environment may have a major impact on the performance of a pesticide, application system, or strategy. The physical environment should be considered during project design, conduct, and data evaluation and described in the pilot project report. It is assumed that the pilot project will be conducted at a location that is physically comparable to where it may be deployed operationally. Topography (elevation, slope, surface cover, and soil types) and atmosphere (wind, temperature, and moisture) can have a dramatic influence on performance of a pesticide, application systems, or strategies. Monitoring procedures and resulting data should be included in the report. To illustrate, application success in a low elevation, moderate terrain may not be repeatable in higher elevations and more complex terrain. Similarly, atmospheric conditions combined with topographical factors, may have a dramatic influence on dispersion of sprays and performance of equipment.

Meteorological measurements should be collected to:

1. Aid in spot forecasting and scheduling.

2. Provide the project director information for operational decisions.

3. Document events for post-spray analysis, modeling, and legal reference.

Two references on forest meteorology are:

Ekblad, R. B., H. E. Cramer, and R. K. Dumbauld. 1978. Meteorological considerations and measurements. In: The Douglas-fir Tussock Moth: A Synthesis; Forest Service, Science and Education Agency, Technical Bulletin 1585. U.S. Department of Agriculture, Washington, D.C.

Schroeder, Mark J. and Charles C. Buck. 1977. Fire Weather. Agriculture Handbook 360. U.S. Department of Agriculture, Forest Service, Washington, D.C.

F. Measurement of Physical Performance

The pilot project should provide for acquisition of data to evaluate the physical performance of the pesticide, application system, or strategy. This often is overlooked by scientists who may focus primarily on biological results. To illustrate with an example - you are testing a proven pesticide against a defoliator that concentrates in the upper tree crown. The test did not meet your control expectations and you may have doubts about its effectiveness. Why did it not perform? To evaluate this poor performance you need data on spray deposition in upper crown, spray atomization, aircraft calibration and performance, aircraft application, physical properties and handling of the tank mix, as well as information discussed in paragraphs II, E.

G. Environmental Monitoring

Design and conduct of pilot projects should consider environment protection consistent with the National Environmental Policy Act. Equal protection should be provided on private, State, and Federal lands. The pilot project objective should include determining or evaluating potential environmental impact of the pesticide, application system, or strategy being tested. Recognizing that such data may have been obtained during field or development testing, it is important to recognize that the purpose of a pilot project is to evaluate performance under semi-operational conditions. As an example, drift may be minimal on a 20 acre block when sprayed by a small helicopter close to the canopy, over moderate terrain. Scaling up from a 20 acre field experiment to a pilot project may involve several thousand acres, the aircraft may be a large helicopter or fixed-wing that flies higher above the canopy, and the terrain more complex.

Drift is inevitable - but how much and is there an impact? Such data are needed for operational evaluations.

H. Pesticide Application Equipment, and Strategies

The system being evaluated on a pilot project should be the system that in all probability would be deployed operationally. The project may be for a pesticide, an item of application equipment, a strategy, or a combination of these three. The pesticide tank mix, the aircraft and atomizer type, and strategy to be evaluated on a pilot project should be the same system planned for operational use; recognizing practical considerations.

WO/FPM staff is available to assist in reviewing work plans and operation plans, and providing advice as requested.

I. Reporting Results

Timely reporting of pilot projects is essential to efficient use of the technology being evaluated. A preliminary report should be available

within four months of completing the field operation and a final report within one year. Journal publications should be considered when appropriate. The preliminary report may be critical to budget planning of follow-on testing or for operational deployment of the tested product.

****

This draft 6-22-89 considered comments received from M.Ollieu, D.Hamel, and G.Daterman.

This draft 7-20-89 considered comments received from J.Weatherby, G.Daterman, R.Reardon, D.Hamel, and T.Hofacker.

This draft 8-31-89 considered comments received from WO-FIDR, WO-FPM (D.Hamel); NA (D.Kucera, J.Hanson, I.Millers); PNW (G.Daterman); R-6 (B.Ciesla); Idaho (L.Livingston); R-8 (J.W.Taylor); and R-2 (D.Johnson).

RECOMMENDED GUIDELINES FOR DESIGNING FIELD EXPERIMENTS OF INSECTICIDES FOR CONTROL OF INSECT DEFOLIATORS BY AERIAL APPLICATION

PURPOSE

The purpose of this document is to set forth some guidelines that can be used by private industry, consultants, and others in planning field tests for aerial application of insecticides to control forest defoliators. This document describes the types of parameters and experimental design considerations that Forest Service scientists consider when evaluating the results of an insecticide field experiment to determine whether it warrants pilot testing. These guidelines are not meant to be rigid unalterable criteria, or exhaustive, but they will serve as a focal point for discussion in planning insecticide field tests.

INTRODUCTION

The Forest Service, USDA, uses a progression of tests to evaluate and recommend various insecticides for use in operational resource protection. These include laboratory screening, field experiments, and pilot projects. Here, the term insecticides refers to any material distributed for the purpose of protecting a forest resource from insect pests, and may include agents that kill the pest with some form of toxicant, or other materials that prevent a necessary behavior such as feeding, mating, ovipositing, aggregation, etc. Field experiments are conducted to evaluate one or more of following; determine the minimum effective dosage rates, different strategies, or formulations of the same material, or different applications equipment. In contrast pilot projects evaluate the most promising treatments identified by field tests. Usually only one variable, for example dosage or volume, is evaluated and the plots are large enough to simulate operational conditions. These operational simulations include such items as uncontrolled multiple swathings, formulation and mixing characteristics of large quantities, use over wide variations in physical conditions etc.

Regardless of the type of program being conducted it is critical to state the objective clearly, concisely and as specifically as possible. The objective may be to estimate treatment effects (contrasting postspray populations levels in both treatment vs. control, or population reductions by treatment vs. control etc.) or specifications to be met (i.e. a treatment must reduce the population at least 90% to be judged effective). Some field tests of insecticides may be planned to determine the lowest effective dose to achieve a certain percent control or residual population for each treatment and to compare treatments. Usually, experiments with such general purposes are evaluated by analyses of variance (ANOVA) with appropriate contrast for determining differences in treatment means.

To arrive at an effective design for either hypothesis testing or point estimation we must consider variabilility and cost. Because the criteria for judging effectiveness for the two goals are different, the design parameters, such as number of plots (replicates), number of trees (subsamples within a replicate) may differ. In many instances, however, both hypothesis testing and

point estimation are important in a single field experiment. It seems reasonable then that the design parameters that meet the design criteria for one goal and exceed the criteria for another goal should be used.

All insecticides used by the USDA Forest Service are registered by the U.S. Environmental Protection Agency (EPA) under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended. However, additional research may need to be conducted on registered insecticides for the purpose of: (1) extending a registration to a new pest; (2) evaluating an insecticide's fate in the environment, (3) field testing an insecticides on a small scale, or (4) assessing environmental effects in specific forest habitats. When field tests are conducted on less than 10 cumulative acres,

[illegible] experiment. It seems [illegible] cooperators that [illegible] the desired crop [illegible] for another year and be used).

[illegible] Pesticides are registered by the [illegible] (EPA), under the authority of the Federal [illegible] Fungicide, and Rodenticide Act (FIFRA), as amended. However, additional research may need to be conducted on registered insecticides for the purposes of: (1) extending a registration to a new pest; (2) evaluating an insecticide's fate in the environment; (3) field testing an insecticide on a small scale; or (4) assessing nontarget effects in special habitats. When field tests are conducted on less than 10 acres, they [illegible]

experimental use permits (EUP) are not required. If research is done on an unregistered pesticide on more than 10 acres then an EUP is required and the guidelines in 40 CFR 172 must be followed. In addition to EUP's, it is usually appropriate to prepare a Forest Service pesticide-use proposal (FS 2100-2) for review, concurrence, and approval of the intended use.

EXPERIMENTAL DESIGN

1. Treated Areas: The following should be considered when selecting areas to be aerially treated with pesticides:

(1) First, the physiological health (quality) of the pest population should be known. Use of pest populations with recent history of stresses (i.e., acute competition for food, starvation, high virus incidence, recent epizootics, high level of parasitic activity of other chronic microbial infections) should be avoided if possible or at the very least noted. Using such populations of low quality could cause confounding effects and raise doubt concerning the reliability of the test results.

(2) Block size should be based on two considerations: (a) mobility of the pest and (b) type of aircraft planned for use. Blocks of at least 20 acres should be used when the target pest is not mobile and blocks of at least 30 acres should be used if the target pest tends to be mobile. Helicopters should be used to treat small blocks.

2. Replication: The function of replication is to provide an estimate of experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects. The number of replications that will be required in a particular experiment depends on the magnitude of the differences to be detected and the variability of the data encountered. An experimental unit refers to the unit to which a treatment is applied. It can be a single leaf, an entire plant, or an area of ground containing many plants. Treatment replication is achieved when a treatment is randomly assigned to more than one experimental unit. Ensuring adequate replication within the confines of applicable constraints, such as manpower and cost, usually requires that treatment plots be small, i.e. 20-50 acre plots.

3. Randomization: Randomization functions to assure unbiased estimates of treatment means and experimental error. When conducting a field experiment to establish the efficacy of aerially applied insecticide in forestry, it is recommended that 2 or more variables (e.g., dose and volume) be tested in the same experiment. It is also further recommended that each variable be replicated 5X (no less than 3X will be accepted) and all treatments (including the fully replicated control) are to be assigned at random.

4. Sampling: Depending on the insect species, an appropriate sampling design must be described in detail so that population estimates can be displayed with their attendant measures of variation (standard deviations, standard errors of the mean etc.). Efficacy testing will be evaluated using

acceptable sampling designs. Treatment effects will be measured with, at minimum one pre treatment and one post-treatment estimate of the pest population's density. It is also highly recommended that periodic measurements to estimate treatment effects on the pest population density or of the protective effect of the insecticide be made at different time intervals. These intervals should coincide with the pest's own development rate or at different developmental stages, during the pest's active (e.g. feeding) period.

5. Data Analyses: To account for treatment differences, given natural differences and sampling error, the variables of interest must be defined i.e. the ratio of insects to foliage after treatment vs. before treatment. An estimate of this variable or other variables of interest and the components of the variances of the estimates can be computed on the basis of ratios of the plot means. Usually, the experiment will be designed to test differences between dose levels, or between treatments and control, for a number of insecticides. In this example, analysis of the experiment will then be evaluated by a one-way ANOVA with plot ratios as observations (experimental units) and insecticides at various levels with control treatments. Establishing confidence intervals for the treatment means provide an additional set of statistics that can be used to determine differences between treatments.

REQUIRED ANCILLARY DATA

1. Plot Descriptions: It is often helpful to describe the stand characteristics within which the experiment was conducted. This can often be useful in extrapolating the results to other geographical areas other than where the original experiments were conducted.

2. Spray Measurements: At a minimum spray deposit cards should be used to obtain a verification of qualitative spray deposits.

3. Aircraft and Spray Characterization: Data must be provided that describes aircraft type, aircraft speed, flow rate, nozzle type, number of nozzles, swath width, volume delivered per acre/hectare, active ingredient per acre/hectare, drop size, some measure of droplet distribution, droplet density etc.

4. Product Quality: In some instances (e.g., microbial pesticides), it is appropriate to test for product potency (quality) prior to use of the product. This will require drawing a pretreatment sample/s for bioassay. Analysis can be directed at determination of potency but can also be used to determine contamination if desired. With chemical insecticides it is recommended that tank samples be taken for each mixing batch for later determination of chemical concentration.

treatment effects will be measured with [illegible] non-consecutive [illegible] highly recommended that periodic [illegible] pest population densities [illegible] treatment at different [illegible] period with the pretreatment [illegible] during the test's [illegible] period.

5. Data analyses: To account for [illegible] differences, given natural differences [illegible] error, the variables of interest must be [illegible] the ratio of insects to [illegible] estimate of this variable [illegible] the sources of the estimates [illegible] plot [illegible]. Finally, the experiment will be designed to test for differences between [illegible] between treatment and [illegible] insecticides. In this example, analyses of the [illegible] will [illegible] by a one-way ANOVA with plot ratios as observations [illegible] and insecticides [illegible]. Establishing confidence intervals for the treatment means [illegible] additional statistics that can be used to [illegible] differences between treatments.

[illegible] options: It is often helpful [illegible] changes [illegible] the experiment was conducted. This can often be useful [illegible] the results [illegible] when the original experiments were conducted.

a. At a minimum [illegible] deposit rates should be used to quantitative spray [illegible].

[illegible] examination. [illegible] flow rate, nozzle type, number of [illegible] active [illegible] of droplet distribution, droplet density

[illegible] et al., microbial [illegible]

[illegible] product to [illegible] the product [illegible] Analysis can [illegible] potency but can also be used to determine [illegible] With chemical [illegible] is recommended that [illegible] mixing batch [illegible]

FURTHER CONSIDERATION

If desired, Forest Service personnel are available to review study plans prior to conduct of the field tests. To insure a timely and helpful review these study plans should be submitted to Director, WO-FPM, at least 45 days before test implementation.

DEFINITIONS

Analysis of Variance (ANOVA)- A statistical technique used to assess how several independent variables (ie. treatment groups) affect the mean(s) of the dependent variable (ie. insect population, defolation). ANOVA is usually concerned with comparisons involving several (> 2) population means.

Control (Checks) - A series of experimental units (ie. plots) receiving either the standard treatment or no treatment, but included in the experiment under the same conditions as the treatment of interest (ie. insecticide) and not systematically different from them.

Experimental-Use Permit - A permit issued by the Environmental Protection Agency of a State to allow experimentation with an unregistered pesticide or to allow a new use of a registered pesticide. The permit is issued upon determination that the applicant needs such a permit to gather information necessary to register the pesticide for a new use (40 CFR 172, Experimental-Use Permits).

Field Test - A research project considering several insecticide treatment variables under a variety of field conditions.

Operational Project - A full scale control project designed to utilize the best treatment materials, equipment, techniques and strategies available to treat a problem (in this instance, a forest defoliator infestation).

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) and substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A special project that considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy under simulated operational conditions.

Randomization - The assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment

Registration - The process whereby the Environmental Protection Agency and States regulate the use of pesticides under authority of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

Replication - The randomized treatments (including controls) are repeated on 2 or more experimental units. Its function is to provide an estimate of

experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects.

Experimental Units - Area (plots) or objects (trees or leaves) that a single treatment is applied to and from which samples are drawn. The complete collection of these experiment units is the population to which inferences are made.

SELECTED REFERENCES

1. Williams, C.B. Jr., D.A. Sharpnack, L. Maxwell, P.J. Shea, and M. D. McGregor. 1985. Guide to testing insecticides on coniferous forest defoliators. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station. Gen. Tech. Rept. PSW-85. 38pp.

2. Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs. 54(2):187-211. (esp p199-204).

3. Little, T.M. and F.J. Hills. 1978. Agricultural Experimentation. Design and Analysis. J. Wiley and Sons. 350pp. (esp.p5-11)

4. Milliken, G.A. and D.E. Johnson. 1984. Analysis of Messy Data. Chap.4. Basics of Experimental Design. Lifetime Learning Publ. NY,NY. 398p. (esp. p47-50).

FD-8/8/89
PJS

SECTION 4

<u>SECOND REPORT</u>

National Steering Committee for Application of Pesticides - Vegetation Management

May 11, 1990

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

I. INTRODUCTION

The second meeting of the National Steering Committee for Aerial Application of Pesticides - Vegetation Management met in West Sacramento, California, on March 7-8, 1990.

A. Committee Members

Phil Aune	PSW/TMR	(Redding, CA)
Garth Baxter	R-4/WO	(Ogden, UT)
Ken Bentson	PNW	(Portland, OR)
Robert Campbell*	FPMI	(Sault Ste. Marie, Ontario)
M. Boyd Edwards*	SE/TMR	(Dry Branch, GA)
Larry Gross	WO/FPM	(Washington, DC)
Ellis Huddleston	New Mexico State University	(Las Cruces, NM)
Paul Mistretta	R-8/RO	(Atlanta, GA)
Ed Monnig*	R-1/FPM	(Missoula, MT)
Max Ollieu	WO/FPM	(Washington, DC)
Donald Perala	NC/TMR	(Grand Rapids, MI)
Michael Rutty	Stanislaus NF	(Sonora, CA)
Fay Shon	R-6/RO	(Portland, OR)
Larry Yarger*	NA/FPM	(Milwaukee, WI)
Jack Barry (Chair)	WO/FPM	(Davis, CA)

Members names followed by an asterisk were not in attendance. Robert Campbell, FPMI, was unable to attend due to foreign travel restrictions.

B. Committee Objectives

The objective of the USDA Forest Service (FS) National Steering Committee for Application of Pesticides - Vegetation Management is to review the needs and recommend pilot project and field testing of herbicides. The committee's charter was expanded in 1989 to include ground application.

C. Operating Guidelines

Operating guidelines, generic to the four FPM national steering committees, are enclosed in **(Appendix A)**.

II. RECOMMENDATIONS

Recommendations for national attention are ranked by priority with one being the highest priority. The committee also recommends the staff and in some cases names a staff person to initiate the recommended action. The staff or person may choose to delegate the action to other organizational elements, staff persons, or to contractors.

A. Administration

1. Broaden charter of this committee to include all methods of vegetation management and review geographic representation on the committee in view of expanded charter; and change committee title to "National Steering Committee For Managing Vegetation on Forest and Range Lands".

   Priority 1 - Chief

2. Involve R-3 as a partner with R-4 in developing a risk assessment for all herbicides registered for forest and range use.

   Priority 1 - Chief

3. Lift the deferral on aerial application of herbicide.

   Priority 1 - Chief

4. Identify Forest Health as a priority research program.

   Priority 1 - Chief

5. Develop a program or initiative to inform the public on how the Forest Service manages national forest and range lands. The program would include vegetation management. The audience would include general public, to include students of all grades; state and private cooperators; and other Federal agencies.

   Priority 2 - Chief

6. Clarify relationship of Forest Service and State pesticide certification program.

   Priority 2 - WO/FPM

7. Evaluate opportunities to cooperate with New Mexico State University in spray technology, vegetation management, and biodiversity and ecosystem system impact research.

   Priority 3 - WO/FPM

B. Training and Technology Transfer

1. Analyze national, regional, and area needs for herbicide-use training to include safety, material safety data sheets, State requirements, certification training, treatment prescriptions, and theory vs practice.

   Priority 1 - WO/FPM & TM
   Regions
   NA

2. Encourage Forest Service support and participation of the Western Regional Coordinating Committee (WRCC-51) and Southern Regional Information Exchange Group on Pesticide Application Technology (SRIEG No. 29).

Priority 2 - WO/FPM

C. Cost Benefit Information and Decision Support Systems

1. Develop a decision support system for vegetation management prescriptions.

Priority 1 - WO/TM

2. Develop a national economic threshold model or model shell.

Priority 2 - WO/TM

3. Develop a national system to monitor vegetation management projects at the forest level, from planning, to treatment, to achievement of the desired result (e.g. tree crown closure).

R-6/FPM

D. Environmental and Safety Needs

1. Develop in cooperation with the Regions a computerized national risk assessment program.

Priority 1 - WO/FPM

2. Develop a national system to gather worker safety information for non-chemical methods of vegetation management.

Priority 1 - WO/FPM

3. Develop a system to collect, catalogue, and retrieve environmental fate data.

Priority 1 - WO/FPM

4. Support forestry worker exposure and safe work method studies, through NAPIAP, special project, and program funds.

Priority 1 - WO/FPM

E. Biodiversity and Ecosystem Impact

1. Develop a national policy on biodiversity, to include defining biodiversity, identifying WO staff responsibilities, and developing a national action plan.

Priority 1 - Chief

2. Support and initiate long-term studies (5-20 years) to monitor various vegetation management alternatives in the Lake States, Southwest, and Southeast.

Priority 1 - WO/FPM

3. Incorporate biodiversity in the PSW, R&D program and other applicable R&D programs.

Priority 1 - Research

4. Establish and maintain a bibliography and library of information (published papers, reports, "fugitive" literature, etc.) on vegetation management research and control projects.

Priority 1 - WO/FPM

F. Application Technology and Equipment

1. Evaluate use of the FSCBG and AGDISP aerial spray models for ground applications.

Priority 1 - WO/FPM

2. Review and update as appropriate the WO/Engineering (MTDC) publications: Catalogue Revegetation Equipment (Feb 1980) and Equipment For Reforestation and Timber Stand Improvement (Oct. 1980).

Priority 2 - WO/Engr.

III. PROGRESS

A. Summary of Progress Related to Committee's 1989 Recommendations.

1. Administrative

a. Director, WO/FPM and Director, WO/Policy and Analyses are developing a staff paper on role of FPM in vegetation management.

b. Director WO/FPM updated the Chief on national deferral of aerial application of herbicides.

c. PSW has drafted a Memorandum of Understanding for vegetation management research cooperation with Canadian Forestry Service's Forest Pest Management Institute (FPMI).

d. WO-FPM has drafted an MOU for pest management cooperation with FPMI.

e. A committee membership was extended and accepted by FPMI.

f. This committee is helping to focus attention among staffs (NFS, S&PF, and Research) on vegetation needs and issues.

2. **Training and Technology Transfer**

Pesticide-use training has been conducted by R-1, R-4, R-5, and R-8. Additionally WO/FPM conducted a national pesticide - use management course at Marana, Arizona.

3. **Decision Support Systems**

a. PSW is developing decision support systems for vegetation management.

b. R-6 is developing a decision making system.

4. **Environmental and Safety Needs**

a. NAPIAP has been encouraging and funding environmental fate studies.

b. WO/FPM is actively supporting re-registration of herbicides.

c. WO/FPM is supporting work to obtain risk assessment data on pesticides through NAPIAP.

d. WO/FPM is cooperating with the Society of Environmental Toxicology and Chemistry by supporting a platform session at their annual meeting (November 12-16, 1990). The session is <u>Pesticides In Forest Management:</u> <u>Predicting and Observing Fate</u>.

e. WO/FPM has membership on a national technical advisory committee sponsored by the National Agricultural Chemical Association (NACA). This committee provides technical recommendations to NACA on spray accountancy and drift studies to support pesticide registration and re-registration.

f. SO, PNW, and NC are conducting environmental fate studies of selected herbicides.

5. **Biodiversity and Ecosystem Impacts**

The committee noted the emergence of biodiversity as a leading national issue and projects that biodiversity will significantly influence vegetation management practices in the future.

6. **Application Technology and Equipment**

a. A project has been established at MTDC to investigate methods of plot marking and navigation systems for aircraft.

b. An intensive program was begun in 1989 to distribute two computer-based aerial spray models (FSCBG and AGDISP) to industry, academia, and governments. Concurrently an advisory committee and user groups were formed, and hands-on training has been given throughout the United States.

c. R-8 continues to take the lead in supporting training and use of hand-held herbicide application methods.

B. Committee Member Reports

Reports by committee members Phil Aune, Ken Bentson, Boyd Edwards, Paul Mistretta, Ed Monnig, Don Perala, Mike Rutty, Fay Shon, and Larry Yarger are enclosed in **Appendix B**.

IV. DISCUSSIONS AND OTHER NEEDS

This committee was established in 1988 to identify needs and to recommend field tests (experiments) and pilot tests of aerially applied herbicides. It became apparent at the 1989 committee meeting that aerial application could not be singled out as a national issue without comparable consideration being given to all other methods of vegetation management. It was, therefore, within this context, that the committee recommended that the charter of this committee be expanded to include all methods of managing vegetation on forest and range lands. Consistent with the expanded charter the committee recognizes the need to recruit others for membership who are nationally recognized specialists in vegetation management.

Other needs include efficacy data on specific herbicides for forest and range use to include plant stress data for timing application, and canopy penetration studies. Regional pesticide-use coordinators could coordinate projects with field users, industry, universities, and researchers. Specific R-5 needs that were discussed included: field evaluation of the Herbi sprayer for application of new herbicide formulations; procedures for sole-source contracting of "turn-key" applications (applicator + herbicide + applicator equipment); and determining aggregate cost of the NEPA process - appeals, project delays, and legal actions resulting associated with herbicide projects.

Some members expressed the need for better coordination and communication among entities conducting vegetation management research. After some discussion it became apparent that this need was, for the most part, being taken care of by various cooperatives, conferences, and committees. With the exception of the Weed Society of America, and other professional societies, most address local, state, or regional needs. The Forest Service does participate in these groups to the extent that their activities relate to forests and range; and use this media to exchange data and information with States, academia, industry, and other federal agencies. It, therefore, appears that the mechanism is in place for technical exchange of information and data.

[illegible] and [illegible] [illegible] [illegible] [illegible] [illegible]
aerial spray [illegible] [illegible]
tests, and experiments. [illegible] [illegible]
[illegible] and [illegible] groups were formed, and [illegible]
[illegible] has been given throughout the United States.

c. R-8 continues to take the lead in supporting [illegible] [illegible]
use of hand-held herbicide applicator [illegible].

9. Committee Member Reports

Reports by committee members Phil Aune, [illegible] [illegible] [illegible]
Paul [illegible], [illegible] [illegible], [illegible] [illegible], [illegible] [illegible], [illegible] [illegible] [illegible]
Larry [illegible] are enclosed in Appendix 6.

[illegible] AND OTHER NEEDS

This committee was established in 19[illegible] [illegible] [illegible] [illegible] and to recommend
field tests (experiments) [illegible] [illegible] tests [illegible] [illegible] [illegible]
herbicides. It became [illegible] [illegible] the 19[illegible] [illegible] [illegible] [illegible] that [illegible]
[illegible] could not be singled out [illegible] [illegible] [illegible] [illegible] without
[illegible] consideration being given to all other [illegible] [illegible] [illegible] [illegible]
[illegible]. It was, therefore, within this context, that the [illegible]
recommended that the charter of the [illegible] be expanded to [illegible] all
methods of managing vegetation on forest and range lands. Consistent
with the expanded charter, the committee recognizes the need to [illegible]
[illegible] [illegible] [illegible] [illegible] nationally recognized [illegible] [illegible]
[illegible] management.

1. [illegible] efficacy data on specific herbicides for [illegible] [illegible]
to include plant species data for [illegible] [illegible], [illegible] [illegible]
[illegible] studies. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] projects with [illegible] [illegible], industry, [illegible] [illegible], and
[illegible]. Specific R- [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] of new herbicide
[illegible] for [illegible] [illegible] [illegible] of [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] cost [illegible] the [illegible] process - [illegible], [illegible] delays
[illegible] [illegible] associated with herbicide projects

[illegible] for [illegible] [illegible] on [illegible] [illegible]
[illegible] [illegible] research [illegible] [illegible]
[illegible] [illegible] the [illegible].
[illegible], [illegible] [illegible], and
[illegible] [illegible] [illegible] of America, and other
[illegible] local, state, or regional [illegible]
[illegible] tours [illegible] [illegible]
[illegible] and [illegible] [illegible]

Ellis Huddleston expressed the interest of New Mexico State University in forest pest management activities. These include pesticide-use training, economic analyses and cost/benefit studies, biodiversity, long-term study plots (forest and range), wind tunnel studies, and a large (section size) field test site.

I would like to take this opportunity to make a personal observation and call attention to a trip report by James H. Miller, of the Southern Forest Experiment Station, Auburn, Alabama, who visited China during April and May 1989 even though we did not discuss it at our steering committee meeting. An Executive Summary of his trip report is included as Appendix C. I suggest everyone with interests in vegetation management, who has not already done so, obtain a copy of James Miller's trip report. As I read the report, I became vividly aware that some land managers have few vegetation management options. Their land has been stripped of native vegetation, their soils sterile and eroded, and their harvests insufficient. While we focus on biodiversity, cultural pest management, and priority research programs, other countries are concerned about basic survival of people and forests. Therefore, while the Forest Service struggles over the use of herbicides, and rejects their use, other countries desperately need to use them and use them effectively for survival. Who will be supporting herbicide-use technology and who will take it to these countries? With our world forestry responsibilities I believe we have a responsibility to maintain our leadership in safe, efficient, and economic use of herbicides.

VI. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Vegetation Management met in West Sacramento, California on March 7-8, 1990. The committee membership was expanded to include Forest Pest Management Institute (Canada) and academia (New Mexico State University). The committee developed several recommendations; and reviewed and discussed accomplishments related to but not necessarily a result of the committees 1989 recommendations. The committee identified biodiversity a significant issue that will influence future vegetation management activities. The committee recommends that the committee charter be expanded to include all methods of managing vegetation on forest and range lands, and that its membership be expanded accordingly.

The next meeting of the committee has been tentatively scheduled to be held the week of September 24-26, 1990 at Corvallis, Oregon.

****

APPENDIX A

OPERATING GUIDELINES
FOR
NATIONAL STEERING COMMITTEES
CONSIDERING
FIELD TESTS AND PILOT PROJECTS
FOR THE
AERIAL APPLICATION OF PESTICIDES

MEMBERSHIP: Committees members should be nationally recognized research, developmental, and applied scientists as well as natural resource professionals drawn for the most part from the Forest Service but also from other Federal and State agencies.

PURPOSE: The committees' primary tasks are to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperators ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

PROCEDURES:

The committees shall:

- meet at least annually, preferably during late summer or early fall so recommended projects can be considered for approval, funding, and implementation the next field season.

- focus on sound science that may lead to improving pesticide application consistent with its stated purpose.

- assign priorities to testing needs agreed to by the committee.

- review data and progress of field and pilot tests.

- suggest who might conduct future tests and where the tests might be conducted.

- take action to address needs such as development of guidelines for field test and pilot projects, database formats, and literature studies.

- establish sub-committees to pursue single issues such as review of laboratory and field test data.

The members shall:

- determine pesticide application needs within their geographical, administrative or organizational area prior to each meeting.

- be cognizant of all appropriate Region/Area/Station/State/cooperator needs.

- bring to the meeting needs that have been discussed with line officers and staff.

- represent the unit's needs within the national perspective of the committee.

The Director FPM/WO shall:

- coordinate the report recommendations within WO, and with the Regions, NA, and Stations as appropriate.

- review the steering committee recommendations and resultant FPM project proposals for funding.

- give strong consideration to the steering committees recommendations in prioritizing project proposals for funding.

- complete project approval and funding by January for projects funded by FPM.

APPENDIX B
Phil Aune

CHARTER FOR A

VEGETATION MANAGEMENT ALTERNATIVES
FOR REGENERATION OF CALIFORNIA CONIFERS

RESEARCH AND DEVELOPMENT PROGRAM

Recommended:

Raymond L. Weinmann 4/16/87
Assistant Regional Forester, TM, R-5 Date

Ronald E. Stewart 4/17/87
Assistant Station Director, CR-NC, PSW Date

Approved:

for Raymond L. Weinmann 4/16/87
Regional Forester, R-5 Date

Roger R. Bay 4/17/87
Station Director, PSW Date

Concurred:

J. Lamar Beasley 5/8/87
Deputy Chief, NFS Date

5/8/87
Deputy Chief, Research Date

Concurred:

George M. Leonard 5/11/87
For Chief Date

VEGETATION MANAGEMENT ALTERNATIVES
FOR REGENERATION OF CALIFORNIA CONIFERS
RESEARCH AND DEVELOPMENT PROGRAM

I. Justification

Reforestation of cutover lands in California is mandated by two principal laws: the National Forest Management Act (NFMA) of 1976 for the national forests and the California Forest Practices Act for private lands. Both laws require that all harvested forest lands be promptly reforested, following timber harvest, with desirable tree species at adequate levels of stocking. In addition, NFMA requires that the new stands achieve rates of growth necessary to meet Forest Land and Resource Management Plan objectives.

Reforestation is a major investment. For example, the Pacific Southwest Region of the USDA Forest Service currently plants 30,000 to 35,000 acres each year at an average cost of more than $500 per acre. The annual plantation establishment rate is expected to double within this decade as Forest Plans are implemented. Similar investments in reforestation are experienced by the many private forest land owners in the State.

Competition for limited soil moisture is a major cause of plantation failure during the dry Mediterranean summer in California. Competition for water and light with vegetation also reduces the growth rate and vigor of trees and makes the plantation more susceptible to losses from insects, diseases, and tree-damaging animals. Recent restrictions on use of key vegetation control practices, such as herbicides, prescribed fire, and mechanical clearing, may result in use of less effective or more costly alternatives and in failure of new plantations to meet stocking or stand growth requirements. For example, loss of herbicides and the absence of suitable substitutes could reduce the yield on 1.8 million acres of National Forest System lands by about 40 percent, or 400 million board feet per year.

Because of past reliance on herbicides, research and development of alternative vegetation control methods has lagged. Some efforts, such as the PSW/R-5 Administrative Study, "Comparing Manual and Chemical Release of Conifer Plantations", are underway. But such studies are limited in scope and need to be supplemented and integrated with work in other Research Work Units and conducted by cooperators. In addition to identification and development of new tools to control competing vegetation, information is needed on where and how much vegetation management is needed to assure economically-efficient treatments.

II. Mission and Objectives

The mission of this Research and Development (R&D) Program is to develop and evaluate alternative methods for preventing or controlling competing vegetation and to develop a vegetation management decision support system for use in reforestation and stand establishment of important California forest types.

Specific objectives of the Program include:

1. Develop and evaluate alternative vegetation management techniques, such as:

-alternative silvicultural systems (even- and uneven-aged management) and reforestation strategies (sequences of practices, natural and artificial regeneration) that minimize the development or influence of competing vegetation

-alternative vegetation control practices that are environmentally safe and economically efficient.

2. Develop a better understanding of the growth of competing vegetation and the competitive interactions of young conifers, shrubs, weed trees, and herbaceous species.

3. Develop a vegetation management decision support system that includes a small tree growth model incorporating the effects of competing vegetation, existing and proposed forest growth and yield simulators (CACTOS, PROGNOSIS, and ORGANON), effects and costs of alternative vegetation management approaches, and analysis of economic efficiency.

III. Program Organization, Staffing, and Participating Units

The staffing will consist of a Program Manager (GM-13/14) and business and clerical support. The position will be located in Redding at the Silviculture Laboratory. The Program Manager will report directly to the Station Director, PSW and the Station will provide statistical, editorial, and other scientific and administrative support. Broad policy, funding, staffing, and program direction is provided by a Board of Directors, composed of the Regional Forester for Region 5 and the Station Director for PSW.

Research Work Units PSW-4102, "Establishment and Maintenance of Regeneration for California Forests", and PSW-4101, "Silviculture of California Conifer Types," both located at Redding, will be directly assigned to the Program under the direction of the Program Manager. The Silviculture Development Unit (SDU) of Region 5, located at Redding, will have a major role in achieving the objectives of the Program, but will not be directly assigned to the Program Manager. Cooperating units (units that may be involved in individual studies or on a consultative basis) may include the National Forests and the Forest Pest Management Staff of Region 5, and RWU-PSW-4201 ("Range Management Research in California") and PSW-4202 ("Methods and Guidelines for Monitoring Wildlife Populations"), at Fresno; PSW-4251 ("Timber/Wildlife Habitat Interactions") and PSW-4351 (Processes Affecting Management of Pacific Coastal Forests on Unstable Lands"), at Arcata; PSW-4301 ("Environmental Hydrology of the California Snow Zone"), PSW-4501 ("Disease Pests of California Forests") and PSW-4502 ("Biology and Control of Insects Adversely Affecting Regeneration and Establishment of Western Forests"), at Berkeley; and PSW-4403 ("Site-Specific Fire Prescriptions for Chaparral and Related Ecosystems"), PSW-4451 ("The Ecology of Chaparral and Associated Ecosystems"), and PSW-4452 ("Fire Management Planning and Economics"), at Riverside. The Program Manager will coordinate work with cooperating units through normal line officers of the Region and Station, as developed and negotiated through annual plans of work.

The Program Manager, Research Work Units, and cooperating units may carry out the objectives of the Program through cooperative agreements with forest industry, State and other federal agencies, and universities.

The organizational structure of the Program is shown in Exhibit 1 and a list of potential cooperators is provided in Section VII. Cooperation and Coordination.

IV. Schedule of Work

The Program, with the assistance of PSW research work units, the SDU, management specialists of Region 5 and cooperating agencies, and universities, will carry out research and development activities related to completion of the Program objectives. Specific tasks will include:

1. Develop a plan of work to guide the research and development activities for the duration of the Program, by September 30, 1987. The plan will include 5- and 10-year milestones.

2. Develop an annual plan of work for all units, including cooperating units, by September 30 of each year for the following fiscal year. The plan is to include research, development, and demonstration activities.

3. Revise Research Work Unit Descriptions (RWUD's) as needed, by February 1, 1988.

4. Report Program progress and needs annually to the Board of Directors (continuing).

5. Establish and maintain coordination and support of the Program through internal and external contacts (continuing).

6. Disseminate results, findings, and products from the research and development activities in a timely manner (continuing).

7. Conduct a mid-term review of the program accomplishments and direction in FY 1992.

V. Program Duration and Funding

The "Vegetation Management Alternatives for Regeneration of California Conifers Research and Development Program" will have a duration of 10 years, beginning in FY 1987. Because of past and existing research, it is anticipated that important new products will be available within the first few years of the Program. For example, results of an "Administrative Study of Alternatives to Herbicides for Conifer Release" and a cooperative study to develop a first generation small tree growth model will be available by FY 1989. Much of the information needed to meet Program objectives for the Mixed Conifer forest type will be available by FY 1992. Comparable results for the Douglas-fir type will likely become available during the second five-year period of the Program.

The following funding is available in FY 1987:

	Source of funds: Research (thousands of dollars)	Source of funds: NFS (thousands of dollars)
Program Manager and support	$ 50	$ 50
RWU-PSW-4101	367	0
RWU-PSW-4102	411	0
Silviculture Development Unit	0	37
Total:	$ 828	$ 87

In addition, the small tree growth modeling effort is supported by the California Forest Research Association, composed of forest industry, federal, state, and university organizations, at $35,250 for FY 1987.

Based on planned harvest levels in the draft Forest Plans and upon expected vegetation management needs to meet plan goals, the following priorities for research have been established by forest and competing vegetation type: (1) Sierra Nevada mixed conifer/greenleaf manzanita; (2) Sierra Nevada mixed conifer/bearclover; (3) Douglas-fir/tanoak-madrone; (4) Douglas-fir/snowbrush ceanothus; and (5) red fir/lupine-grass. At current funding levels, the Program will concentrate on priorities (1) and (2) and opportunistically initiate key studies in the Douglas-fir/tanoak-madrone type. High costs for study establishment will be experienced during the first few years of the program. As studies in the Sierra Nevada mixed conifer type enter into a maintenance phase, funds will be rapidly shifted into additional research in the Douglas-fir type. This research should be more efficient since it will be based on experience gained in the mixed conifer type. Significant studies of alternative silvicultural systems for each of these forest types will occur only at higher levels of funding.

The first increment of additional funding will be used by the Program Manager as a discretionary fund for specific research and demonstration efforts by participating and cooperating units or university scientists that support Program objectives. A fund of not less than $50,000 nor more than $100,000 is desirable. New funds above this level will be used to accelerate research first in the Douglas-fir type and then in the red fir type.

VI. Environmental Impacts

Environmental considerations will be documented in individual study plans or project proposals. For studies and demonstrations established on National Forest lands, Program activities will ordinarily be included in timber sale/reforestation and individual project environmental assessments. Activities on private lands will meet requirements of the California Environmental Quality Act (CEQA).

VII. Cooperation and Coordination

Effective execution of the Program objectives will require cooperation and coordination with numerous interested agencies and groups. The Program Manager

will need to develop individual contacts and assure timely dissemination of information and involvement of interested parties. Organizations that will have interest in the Program include:

<u>Forest Service</u>
- Region 5 (Siskiyou and Rogue River National Forests)
- Region 6
- PNW Station

<u>Other Federal Agencies</u>
- USDI, Bureau of Land Management-Oregon

<u>State Agencies</u>
- California Department of Forestry and Fire Protection

<u>Universities</u>
- University of California at Berkeley
- University of California at Davis
- Humboldt State University
- Oregon State University

<u>Forestry Associations and Companies</u>
- California Forest Vegetation Management Conference
- California Forest Pest Control Action Council
- California Forest Protective Association
- California Forest Research Association
- Western Timber Association
- Santa Fe-Pacific Timber Company
- Fruit Growers Supply Company
- Michigan-California Lumber Company
- Sierra Pacific Lumber Company
- Roseburg Resources Company
- Collins Pine Company

<u>Private Interest Groups</u>
- Group for Organic Alternatives to Toxic Sprays (GOATS)
- Southern Oregon Citizens Against Toxic Sprays (SoCATS)

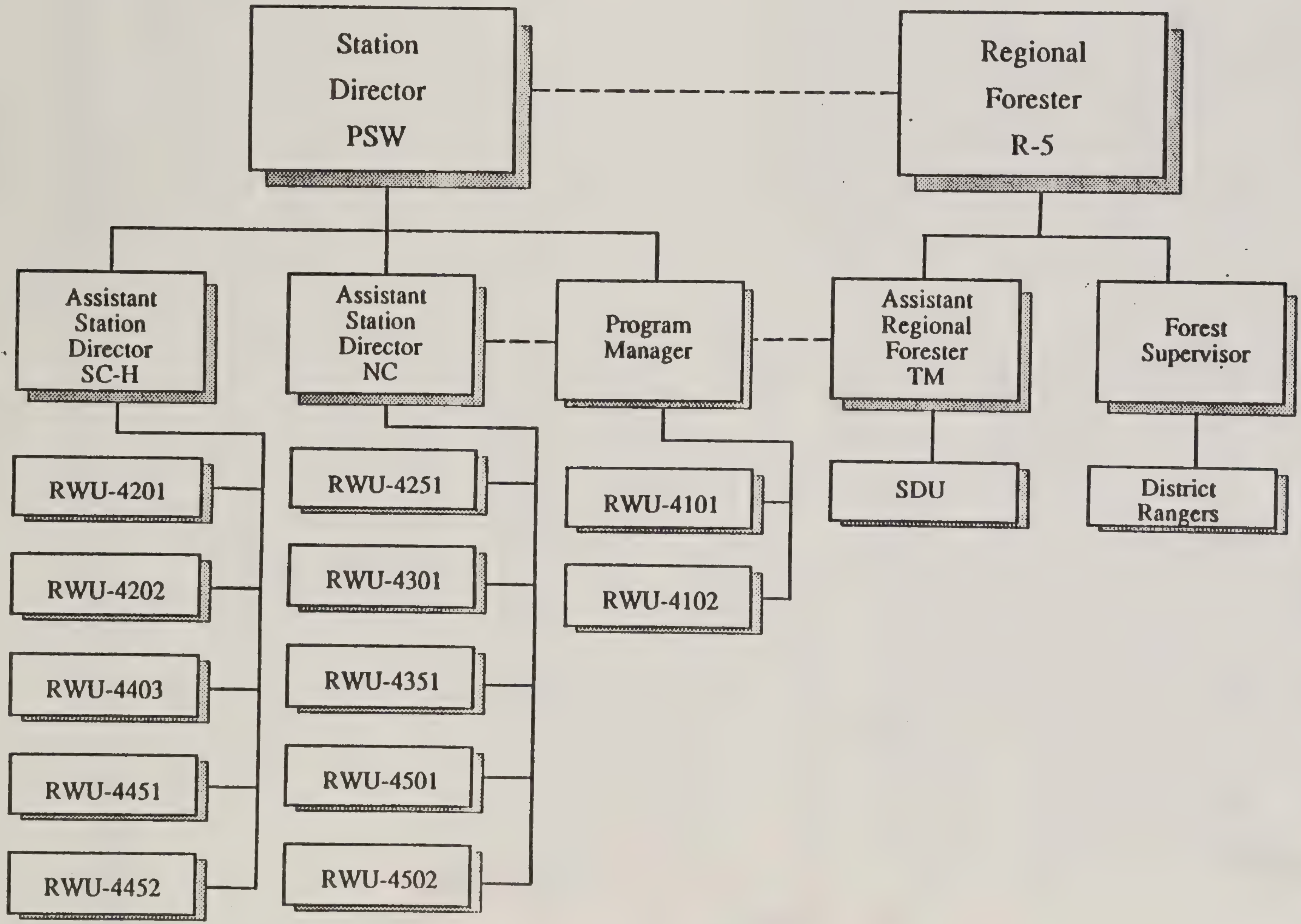
Exhibit 1

ORGANIZATION OF THE RESEARCH AND DEVELOPMENT PROGRAM

		Station Director PSW	Regional Forester R-5	
Assistant Station Director SC-H	Assistant Station Director NC	Program Manager	Assistant Regional Forester TM	Forest Supervisor
RWU-4201	RWU-4251	RWU-4101	SDU	District Rangers
RWU-4202	RWU-4301	RWU-4102		
RWU-4403	RWU-4351			
RWU-4451	RWU-4501			
RWU-4452	RWU-4502			

Exhibit 1

Organization of the Research and Development Program



Phil Aune

ALTERNATIVE TREATMENTS FOR RELEASING CONIFER SEEDLINGS: A STUDY UPDATE[1]

Gary O. Fiddler and Philip M. McDonald[2]

Abstract: A study to find alternatives for releasing young conifer plantations on National Forests in northern California was started in 1980. The scope of the study has been enlarged to include State of California and private industry lands. Thirty two study sites have been established under three categories: National Administrative, Cooperative Release, and Timing of Release. The effects of chemical, manual, mechanical, and animal treatments on the survival and growth of conifer seedlings are being quantified. The oldest study site has had 7 growing seasons since the first treatments were applied. Preliminary findings are emerging. To release conifers, a radius of at least 5 feet is required. Caliper growth is the best indicator of release. Some of the newer chemicals give good results. Mechanical treatments require additional treatments to effectively control shrubs. Manual treatments may be worthwhile but are costly.

[1]Presented at the Eight Annual Forest Vegetation Management Conference, November 4-6, 1986, Sacramento, California.

[2]Supervisory Forester, Pacific Southwest Region and Research Forester, Pacific Southwest Forest and Range Experiment Station, Redding, California

At the Fifth Annual Forest Vegetation Management Conference in 1983, held in Sacramento, California, a new national administrative study on alternatives to herbicides in vegetation management was described (Fiddler and McDonald 1984). It was a Forest Service effort with study sites in several regions. In the California Region, the study is a cooperative effort between the Pacific Southwest Region and the Pacific Southwest Forest and Range Experiment Station.

Since 1983 the study has increased in scope and number of study sites. It now has been divided into three categories, two of which are new. The National Administrative category, where all work is done by the same crew, has increased to 14 study sites located on 8 National Forests. The Cooperative Release category, which involves work by several crews, has 12 study sites located on Forest Service, State of California, and private industry lands. The Timing of Release category, which concerns defining the best time to release conifer seedlings, has 6 studies on Forest Service and private industry lands.

The purpose of this study is to quantify the effect of various chemical, manual, mechanical, and animal treatments on the survival and growth of conifer seedlings, woody shrubs, and other competing vegetation. The objectives of this study are to:

1. evaluate manual, chemical, animal, and mechanical release treatments

2. quantify treatment costs

3. determine tree growth/shrub quantity relationships

4. determine "best" treatment in terms of cost, survival, and growth.

For conifer seedlings, measurements include survival, damage, height, caliper, needle length, and needle color. Measurements on woody shrubs include density, cover, height, and frequency.

Categories of data that are being developed from these measurements include:

1. cost and production data

2. moisture stress relationships

3. conifer responses

4. shrub dynamics.

STUDY AREAS

The study is divided into three categories (table 1): National Administrative, Cooperative Release, and Timing of Release.

Table 1.--Vegetation Management Study Areas

Study Area[1]	Conifer Spp.[2]	Target Spp.	Treatment	Area/Type
National Administrative				
Klamath NF	DF	deerbrush	control	
Salmon River RD		grasses	crop tree release	2,3,4,& 6' radius
			directed spray	2,4-D[3], 3' radius
			directed spray	2,4-D, entire plot
Shasta-Trinity NF	DF	deerbrush	control	
Big Bar RD		madrone	cut and spray	Garlon 3A
		tanoak	crop tree release	5' radius
			directed spray	2,4-D, Garlon 4, and 2,4-D plus Garlon 4
Six Rivers NF	DF	manzanita	control	
Gasquet RD		deerbrush	directed spray	2,4-D, Garlon 4, and 2,4-D plus Garlon 4
		tanoak		
			crop tree release	5' radius
			cut and spray	Garlon 3A
Six Rivers NF	DF	snowbrush	control	
Gasquet RD		manzanita	crop tree release	5' radius
		tanoak	directed spray	2,4-D, Garlon 4, and 2,4-D plus Garlon 4
			cut and spray	Garlon 3A
Lassen NF	PP	manzanita	control	
Hat Creek RD		chinkapin	grub	100%
		snowbrush	simulated aerial	2,4-D, Velpar
			manual crop tree release	4' radius
			chain saw crop tree release	4' radius
Shasta-Trinity NF	PP	manzanita	control	
McCloud RD		chinkapin	crop tree release	2, 4, & 6' radius
		snowbrush	simulated aerial	2,4-D
		grasses	directed spray	Velpar
Tahoe NF	PP	deerbrush	control	
Foresthill RD	SP		grub	100%
	DF		grub	5' radius
			simulated aerial	2,4-D, Velpar
Tahoe NF	PP	deerbrush	control	
Downieville RD	DF		simulated aerial	2,4-D
	SP		directed spray	2,4-D, 3' & 5' radius
			cut brush	100%
Plumas NF	PP	deerbrush	control	
Quincy RD	DF	manzanita	simulated aerial	2,4-D, Velpar
		chinkapin	grub	100%
			crop tree release	2' and 4'radius
			simulated aerial	Roundup
Plumas NF	PP	snowbrush	control	
Quincy RD	JP	manzanita	Hydro-ax	
		chinkapin	Hydro-ax	2,4-D

Tahoe NF Nevada City RD	PP	manzanita whitethorn bittercherry	control Trac-mac Trac-mac	 2,4-D
Tahoe NF Downieville RD	PP DF	deerbrush	seedlings seedlings, brush seedlings, brush, deer seedlings, brush, deer and sheep	
Modoc NF Big Valley RD	PP	grass	seedlings seedlings, grass heavy grazing acceptable grazing	Velpar
Eldorado NF Amador RD	PP	bearclover	control directed spray simulated aerial simulated aerial simulated aerial	 Roundup Velpar Escort Arsenal

Cooperative Release

Klamath NF Oak Knoll RD	PP	live oak	control cut and spray directed spray directed spray crop tree release	 Garlon 3A Garlon 4 Velpar 100%
Klamath NF Salmon River RD	PP	deerbrush	control release, 1 time release, 2 times crop tree release	 100% 100% 5' radius
Klamath NF Happy Camp RD	DF	tanoak madrone	control cut and spray cut and spray cut,spray, and burn cut,spray, and burn cut,burn, and directed spray	 Tordon 101 Garlon 3A Tordon 101 Garlon 3A Garlon 4
Six Rivers NF Mad River RD	DF	tanoak	control crop tree release	 5' radius
Plumas NF Oroville RD	DF	tanoak	control collars collars	 3' radius 5' radius
Plumas NF Oroville RD	DF	tanoak	control basal	 Alumagel
Plumas NF Milford RD	JP	snowbrush	brush, seedlings, sheep seedlings, brush seedlings seedlings	 4 ft. radius Velpar
Shasta-Trinity NF Yolla-Bolla RD	PP	forbs grasses	control grub, 1 time grub, 3 times grub, 1 time grub, 3 times collars	 2' radius 2' radius 5' radius 5' radius 1.5' radius

Eldorado NF	PP	whitethorn	collars, tar paper	20" radius
Amador RD		lupine	collars, felt	20" radius
			collars, Terramat	20" radius
			collars, Pacific weave	20" radius
			collars, Horto paper	20" radius
			collars, black plastic	20" radius
			control	
			directed spray	Velpar
Eldorado NF	PP	deerbrush	control	
Amador RD		manzanita	seedlings only	Velpar
				Velpar (ULW)
				Pronone
Sequoia NF	PP	manzanita	control	
Hot Springs RD			directed spray	Velpar
			collars, thick	5' radius
			collars, thin	5' radius
			collars, sandwich	2' radius
Latour State Forest	PP	chinkapin	simulated aerial	Velpar
			simulated aerial	Garlon 4
			simulated aerial	Escort
			control	
<u>Timing of Release</u>				
Shasta-Trinity NF	PP	manzanita	control	
Mt. Shasta RD		snowbrush	crop tree release	Free to grow 1 <u>st</u> 3 years
		grasses	crop tree release	Free to grow 2 <u>nd</u> 3 years
		chinkapin		
Klamath NF	PP	manzanita	control	
Goosenest RD		snowbrush	crop tree release	Free to grow 1 <u>st</u> 3 years
		chinkapin	crop tree release	Free to grow 2 <u>nd</u> 3 years
Mendocino NF	DF	whitethorn	control	
Corning RD		manzanita	crop tree release	Free to grow 1 <u>st</u> 3 years
			crop tree release	Free to grow 2 <u>nd</u> 3 years
Plumas NF	JP	manzanita	control	
Quincy RD		squawcarpet	crop tree release	Free to grow 1 <u>st</u> 3 years
		deerbrush	crop tree release	Free to grow 2 <u>nd</u> 3 years
Santa Fe-Pacific	WF	manzanita	control	
Stephens Pass	RF	snowbrush	crop tree release	Free to grow 1 <u>st</u> 3 years
		grasses	crop tree release	Free to grow 2 <u>nd</u> 3 years
			free to grow	Study life
Santa Fe-Pacific	WF	whitethorn	control	
Bunker Hill	RF	ribes	crop tree release	Free to grow 1 <u>st</u> 3 years
		forbs	crop tree release	Free to grow 2 <u>nd</u> 3 years
			free to grow	Study life

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[1]NF = National Forest; RD = Ranger District

[2]DF=Douglas-fir; PP=Ponderosa pine; SP=Sugar pine; JP=Jeffrey pine; RF=Red fir

[3]Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the U.S. Department of Agriculture is implied.

Treatments being evaluated in the National Administrative category include:

1. Untreated control.

2. Manually saw or grub around conifer crop trees to predetermined radii of 2, 3, 4, 5, or 6 feet and repeat treatment up to three times.

3. Manually cut or grub all woody shrubs on plots.

4. Hand cut all woody shrubs and chemically treat stubs (daub or direct spray).

5. Direct spray with herbicides or mixture of herbicides to prescribed radii, with a second application as needed.

6. Simulation of helicopter herbicide application, with a second application as needed.

7. Mechanically treat shrubs using heavy equipment, such as the Hydroax or Trac-Mac.

8. Mechanically treat shrubs as in treatment 7 and apply 2,4-D two years later to sprouting plants.

9. Use of cattle and sheep to control competing shrubs by grazing.

All treatments under the National Administrative category are applied by the same crew, assuring uniformity of rates and procedures.

The second category is Cooperative Release studies. These are located on Forest Service, State, and private industry lands, and differ from the National Administrative areas in that the land owner applies the treatments and takes measurements to the same standards as in the National Administrative areas. Twelve study areas have been established to date under this category. Some treatments not included under the National study are being tested under this category. These include use of mats to prevent shrub regrowth following site preparation. The mats are made of kraft paper, felt, or some other synthetic fiber, and range from 4- to 10- feet square. They show promise for grasses, forbs, and shrub species such as deerbrush, but are doubtful for more vigorous shurbs with stiff stems, such as tanoak, where use is limited. This is because, though firmly pinned to the ground, the mats are lifted up by the stems of the growing shrubs. The wind then is able to get under the mats and blow them over the conifer seedlings.

Another treatment tried on tanoak is the use of Alumna-Gel which is a form of jellied gasoline. A shallow ditch is dug around the tanoak stump to expose the root collar. Alumna-Gel is poured into the ditch and set on fire. The intense heat is supposed to kill the buds and prevent sprouting. Results to date have been varied and this study is continuing.

The third category is the Timing of Release studies. These are located on private industry and National Forest lands; seven have been established to date. Their purpose is to determine what period in a conifer seedling's life is the most critical in terms of competing vegetation. In other words, if it is impossible to keep conifer seedlings free of competing vegetation throughout their life, what is the most critical period for them to be free to grow? Treatments include:

1. Control.

2. Maintain area free of competing vegetation for first 3 years, then let it develop naturally for the next 7 years.

3. Let vegetation develop naturally for first 3 years, then eliminate it and keep it eliminated for next 3 years.

4. Keep area free of competing vegetation for the life of the study.

With the three categories of studies, National Administrative, Cooperative Release, and Timing of Release, there are a total of 32 study sites located throughout northern California. The oldest one has had 7 growing seasons since the first treatments were applied. The intent of the study is to produce publications that will report results as soon as possible, with final results published for each study site at the end of 10 years. Several publication outlets will be utilized, although the majority will be Station research papers published through the PSW's Berkeley office. The first one, "Release of Douglas-fir seedlings: growth and treatment costs", is now available. It is Research Paper PSW-182. Two others are being written with publication planned for 1987.

The large number and broad range of studies gives us a good start on examining several alternatives for releasing conifer seedlings. If use of herbicides is limited or banned, the animal and mechanical techniques could prove especially valuable. Use of animals to control competing, but palatable, shrubs provides an opportunity for vegetation control and also early dollar returns from meat and hides. Even though thousands of acres of land in California have been mechanically treated, knowledge on the effectiveness of this technique is lacking. Of particular interest is use of different combinations of animal, mechanical, manual and herbicide treatments. Real opportunities for controlling competing shrubs, forbs, and grasses are possible here, and at a reasonable cost. For all alternatives, the treatment cost/seedling growth relationship should help the forest land manager in decision making.

RLY OBSERVATIONS

In conclusion, some preliminary findings are nerging from the study:

1. When releasing conifers, a radius of at ast 5 feet is required before the conifers show ny significant response.

2. Caliper growth is consistently the best dicator of release. Height growth, at least of ouglas-fir, seems to be independent of ompetition level.

3. Mechanical shrub control appears ineffective ithout additional treatment of shrubs.

4. Manual treatments appear costly but orthwhile for controlling non-sprouting species, specially if applied when weeds are young and not vell established.

5. Some of the newer chemicals are giving effective and lasting results. At least two of our trials show release lasting up to three years from a single application of Velpar. Garlon 4 has given good control of tanoak to date and this control has carried over in the form of reduced sprouting.

6. The most consistent finding is that early release, one or two years after planting, is essential not only for conifer seedling survival, but also for growth. Waiting three years before releasing conifers usually results in growth losses that will never be made up.

LITERATURE CITED

Fiddler, Gary O., and Philip M. McDonald. 1984. Alternatives to herbicides in vegetation management: a study. Pages 115-126 in Proceedings of the Fifth Annual Forest Vegetation Management Conference, November 2-3, 1983. Sacramento, Ca.

March 5, 1990

Addendum to "A Study Update"

Cooperative Release Studies

Study Area	Conif. Spp.	Target Spp.	Treatment	Area/type
Plumas NF	PP	deerbrush (older)	seedlings, sheep seedlings, no sheep	
BLM	DF	tanoak	chainsaw rel. annually yrs 1-10	entire plot
Arcata RA		chinkapin	chainsaw rel. yrs 0,1, 2,5,10	entire plot
			chainsaw rel. yrs 0,5,10	entire plot
			control	
BLM Arcata RA	DF	grasses forbs	polypropylene mulch polypropylene mulch scalp control	5' radius 1' radius 1' radius
Stanislaus Mi Wok RD (Burned area)	PP	bearclover seeded grass	simulated aerial simulated aerial simulated aerial control	Velpar (ULW) Garlon 4 Roundup
Stanislaus Mi Wok RD (Unburned)	PP	bearclover natural grasses	simulated aerial simulated aerial simulated aerial control	Velpar (ULW) Garlon 4 Roundup
Boggs Mtn. State Forest	PP	natural vegetation	opening sizes from 1/4 to 1 3/4 acres	
Lassen NF Hat Cr RD	PP	manzanita bitter cherry snowbrush	June 15 August 15 October 15	Trac Mac Trac Mac Trac Mac
Eldorado NF Georgetown RD	PP	manzanita	nursery run wind pollinated control pollinated	free to grow and with weeds in each genetic class

March 5, 1990

LIST OF PUBLICATIONS

National Administrative Study

1. McDonald, Philip M. 1983. Weeds in conifer plantations of northeastern California--management implications. In: Proceedings of a symposium on the management of the Eastside Pine Type in northeastern California. Susanville, June 15-17, 1982. p. 70-78.

2. Fiddler, Gary O., and Philip M. McDonald. 1984. Alternatives to herbicides in vegetation management: a study. In: Proceedings, 5th Annual Forest Vegetation Management Conference, Nov. 2-3, 1983. Sacramento, CA. p. 115-126.

3. McDonald, Philip M., and Gary O. Fiddler. 1986. Weed treatment strategies to control losses in ponderosa pine plantations. In: Proceedings of a workshop on forest pest management in Southwest Oregon. Grants. Pass, OR. August 19-20, 1985. p. 47-53.

4. McDonald, Philip M. 1986. Grasses in young conifer plantations--hindrance and help. Northwest Sci. 60(4): 271-278.

5. McDonald, Philip M., and Gary O. Fiddler. 1986. Release of Douglas-fir seedlings: growth and treatment costs. USDA Forest Serv. Res. Paper PSW-182, 9 p.

6. Fiddler, Gary O., and Philip M. McDonald. 1987. Alternative treatments for releasing conifer seedlings: a study update. In: Proceedings of the Eighth Annual Forest Vegetation Management Conference. Nov. 5-6, 1986, p. 64-69. Sacramento, CA.

7. McDonald, Philip M., and Gary O. Fiddler. 1987. Growth and treatment costs after release of Douglas-fir seedlings on the Klamath National Forest. In: Proceedings of the Eighth Annual Forest Vegetation Management Conference. Nov. 5-6, 1986, p. 56-63. Sacramento, CA.

8. McDonald, Philip M., and Gary O. Fiddler. 1988. Release of young pines by sheep--no effect after five years. In: Proceedings of the Ninth Annual Forest Vegetation Management Conference. Nov. 3-5, 1987, p. 168-174. Redding, CA.

9. Ratliff, Raymond D., and Philip M. McDonald. 1988. Postfire grass and legume seeding: what to seed and potential impacts on reforestation. In: Proceedings of the Ninth Annual Forest Vegetation Management Conference. Nov. 3-5, 1987, p. 111-123. Redding, CA.

10. McDonald, Philip M., Gary O. Fiddler, and William H. Smith. 1989. Mulches and manual release fail to enhance Douglas-fir seedling survival and growth. In: Proceedings of the Tenth Annual Forest Vegetation Management Conference. Nov. 1-3, 1988, p. 140-153. Eureka, CA.

11. McDonald, Philip M., Gary O. Fiddler, Richard A. Tucker, and Andrew Colaninno. 1989. Manual release in an "old" Douglas-fir plantation increases diameter growth. USDA Forest Serv. Res. Note PSW-405. 3 p.

12. McDonald, Philip M., and Gary O. Fiddler. 1989. Competing vegetation in ponderosa pine plantations: ecology and control. USDA Forest Serv. Gen. Tech. Rep. PSW-113. xx p.

13. McDonald, Philip M., and Gary O. Fiddler. 1990. Growth of seedlings and cost of manual and chemical release in a ponderosa pine plantation. USDA Forest Serv. Res. Paper PSW- (In Press).

14. Fiddler, Gary O., and Philip M. McDonald. 1990. Manual release contracting: production rates, costs, and future. Western Journal of Applied Forestry. (Accepted for publication).

15. Fiddler, Gary O., Philip M. McDonald, and Carl R. Chapman. Mechanical release of pine saplings: ineffective without herbicide. (In Press to Western Journal of Applied Forestry).

16. McDonald, Philip M., and Ole T. Helgerson 1990. Mulches for regenerating California and Oregon forests: past, present, and future. USDA Forest Serv. Gen. Tech. Rep. PSW-000 (In Press).

17. McDonald, Philip M., Gary O. Fiddler. Control of bearclover (Chamaebatia foliolosa) in a young pine plantation in northern California. (In press to Weed Sci.).

18. McDonald, Philip M., and Steven R. Radosevich. Chapter 4. General principles of forest vegetation management. In: A silvicultural Approach to Animal Damage Mangement in Pacific Northwest Forests. USDA Forest Serv. Gen. Tech. Rept. PNW- (In press).

19. McDonald, Philip M., Carl N. Skinner, and Gary O. Fiddler. Needle length--an effective indicator of manual and chemical release. (In press to Canadian J. of Forestry Research).

[illegible] McAllister, Richard A. [illegible], and [illegible] [illegible] "[illegible]" [illegible] plantation [illegible] [illegible]. Res. Note PSW-[illegible]. [illegible] p.

[illegible] O. Fiddler. [illegible] Competing vegetation in [illegible] ecology and control [illegible] [illegible]

[illegible] O. Fiddler. 1990. [illegible] [illegible] [illegible] ponderosa pine plantation. [illegible] [illegible]

[illegible] Gary O. and Phillip M. McDonald. 1992. [illegible] [illegible] past, present, and future. Western Journal of Applied Forestry. [illegible] [illegible] (In press).

[illegible] Fiddler, Gary O., Phillip M. McDonald, [illegible] Paul R. [illegible] [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] herbicide. (In [illegible] Western Journal of Applied Forestry).

[illegible] Phillip M. and [illegible] T. [illegible] 1990. [illegible] [illegible] [illegible] forests: past, present, and [illegible]. USDA Forest [illegible] [illegible] (In Press).

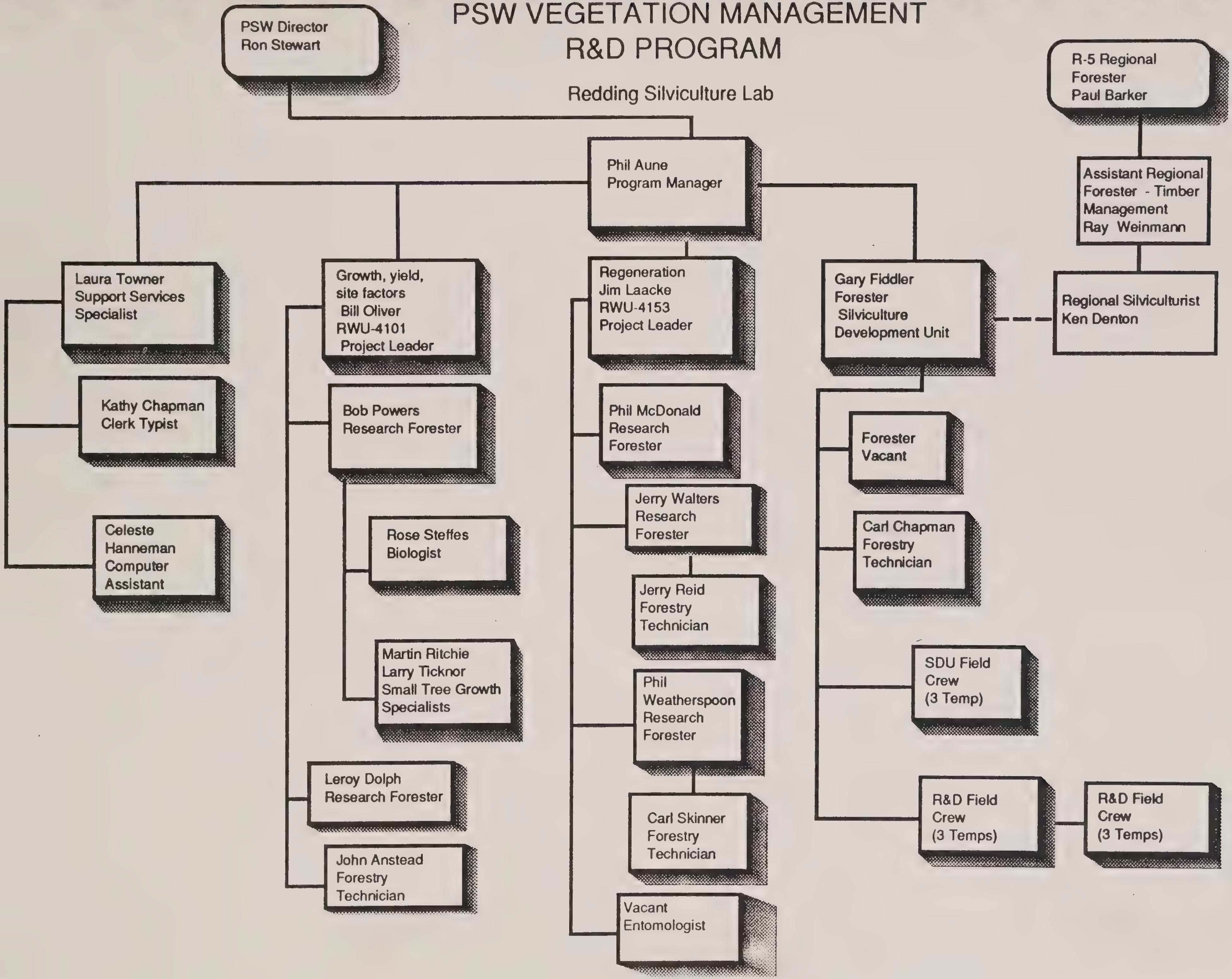
[illegible] Phillip M., Gary O. Fiddler. [illegible] of [illegible] [illegible] young [illegible] plantation in [illegible] [illegible] [illegible]

[illegible] and Steven R. [illegible] [illegible] [illegible] [illegible] management. In: [illegible] [illegible] [illegible] USDA Forest [illegible] [illegible]

[illegible] M. [illegible], and Gary O. Fiddler. [illegible] [illegible] of manual and chemical release. (In [illegible] [illegible] Research).

PSW VEGETATION MANAGEMENT R&D PROGRAM

Redding Silviculture Lab



APPENDIX B
Ken Bentson

HERBICIDE USE RESEARCH NEEDS IN REGION 6

Kenneth P. Bentson, Research Chemist, PNW

R-6 has not had any herbicide use since the 1984 herbicide injunction. The injunction has precluded any research that utilizes herbicides. It is apparent, however, that there are several major areas of research that will be necessary to develop an integrated pest management program for vegetation that includes herbicides. Much of this research is necessary for private as well as public land managers.

The Pacific Northwest is typified by a wide diversity of social, biological, and physical environments. The social environment needs to be investigated in proximity to the National Forests and other timber production areas. Some means of incorporating the social attitudes of local and regional residents into vegetation management decisions should be developed, this goes beyond the NEPA process. Much of the herbicide controversy might have been circumvented if there had been judicious choices made about where to apply herbicides with respect to sensitive residents. Certain areas of the region have few residents concerned about herbicide applications, while other locales have a very strong anti-herbicide movement. Tailoring vegetation management prescriptions to the social environment would help to allay many current problems.

The biological and physical environments of the Pacific Northwest are diverse, ranging from arid rangelands to montane temperate rain forests. The herbicide injunction forced many districts to explore alternative methods of vegetation management, some of which have proven to be highly successful (e.g. hand pulling seedling snowbrush ceanothus, planting very large seedlings). There is a great need for the development of economic damage thresholds for competing plant populations as part of an integrated vegetation pest management program. Economic damage thresholds would establish a stronger basis for the prescription of vegetation management treatments, because treatment selection could be made on the basis of reducing damage to just below the economically damaging level. Identification of plant community and site characteristics, where herbicide applications are the only biologically and cost effective method of reducing damage, is essential to justify the use of herbicides. Some of this work is currently taking place at Oregon State University, however, an accelerated program of determining economic damage thresholds is necessary given the diversity of plant communities in the Pacific Northwest.

Systematic comparisons of the advantages and disadvantages of different vegetation management alternatives need to be made. These comparisons should consider site specific characteristics such as topography, climate, plant community, soils, landslide potential and social ramifications (e.g. visual impact, proximity to people, opinion surveys). For instance, there is currently little data comparing the efficacy, costs, worker exposure levels, and off-site consequences of aerial versus backpack applications of herbicides in different plant communities on sites of different slopes. The effect of slope may have a large impact on the

relative efficacy and worker exposure from backpack versus aerial applications, and thus would become a component in deciding which application technique is most suitable for a specific site. In some areas, the social consequences of aerial applications may be too great for its use.

Canopy penetration and spray adhesion of herbicide on different target plant's foliage needs to be investigated. The diversity of plant species (e.g. grasses, herbs, tanoak, madrone, ceanothus, maple, and manzanita) means that there are many different leaf orientations relative to droplet trajectories, and a wide variety of leaf surface characteristics. These factors have a large influence on the retention and uptake of foliar applied herbicides. Some vegetation types may be best treated with backpack applications because of leaf orientation, while others may have better spray capture from aerial applications. Canopy penetration and spray adhesion are critical in determining the initial environmental sites different fractions of the total herbicide residue is deposited. The site of deposition plays a fundamental role in the subsequent rate of degradation and transport of residues. Various factors which affect canopy penetration and spray adhesion that need to be investigated are drop size, formulation, spray volume, plant leaf surface characterisitics, plant physiological status, dew on foliage, humidity, and temperature. Data collected from this would increase the precision of the FSCBG canopy penetration prediction capabilities.

Environmental fate of herbicides needs study in the context of site specific conditions. Environmental fate studies for registration do not provide information useful for evaluating the potential fate of an herbicide under the variety of climatic and edaphic conditions that prevail in the Pacific Northwest. Consideration of temperature, humidity, insolation, soil types, litter, and vegetation need to be included in environmental fate studies that bridge the gap between the laboratory and field. Environmental fate information gathered along these lines could result in development of predictive models applicable to specific site conditions, and would be useful in site specific environmental assessments.

Models for the prediction of herbicide deposition site, degradation, volatilization, leaching, runoff, and groundwater contaminating potential need to be developed that can be applied to typical forest sites in the Pacific Northwest. The requirement for site specific environmental assessments means that land managers with little training in environmental and pesticide chemistry must make decisions outside their field of expertise. Expert systems to predict the transport of pesticides into sensitive systems (e.g. streams, groundwater, the atmosphere), given the unique conditions prevailing at specific sites and application times, would lead to scientifically defensible environmental assessments. These programs could be linked to geographic information systems. Expert systems would also aid in the development of monitoring systems that would specify where and when samples from different compartments of the system should be sampled.

APPENDIX B
M. Boyd Edwards

COMMITTEE MEMBER REPORT
NATIONAL STEERING COMMITTEE FOR
AERIAL APPLICATION OF PESTICIDES-
VEGETATION MANAGEMENT

M. Boyd Edwards
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It is again a pleasure to have this opportunity to discuss the use and use needs for vegetation management in the southern United States.

As previously noted in last years Report, I have been involved in herbicide use research for approximately ten years and have worked closely with the herbicide industry, foresters in the timber industry, as well as State and Federal foresters for the purpose of determining application methods, herbicide screenings, and the training of herbicide applicators. My personal research efforts have been conducted in the Piedmont and Coastal Plains Region of the southern U.S.

At present, I anticipate aerial application of herbicides to be the "application method of choice" on large private tracts of forest land, and little or no aerial application to be made on public forest lands in the South. Most herbicide application on National Forest land in the South is being conducted by small, hand-crews on individual stems for low impact management objectives. Little or no broadcast of herbicides is being used.

At present we are conducting research to determine efficacy of specific herbicides on numerous species of woody and herbaceous plants for the purpose of establishing planted pine and releasing young pine stands from competition. In addition, there is interest in utilizing herbicides in natural regeneration of pine stands as well as for maintaining adequate species mixes in pine-hardwood stands. Also for the first time herbicides are being studied to determine how they create and maintain biological diversity in southern forests. This is vital information for proper management on National Forest lands today.

A few non-technical problems and needs are:

1. Train Forest Service field crews in making the proper prescription in order to achieve desired management objectives.

2. Maintain cooperation with environmental groups in order to explain the how-and-why of herbicide use in forests.

[illegible]
Forest [illegible]
[illegible] Box [illegible]
[illegible]
[illegible]

[illegible] opportunity [illegible]
[illegible]

[illegible], tested in last years [illegible]. I [illegible] [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] have been conducted in the [illegible] [illegible]

As a result, I [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible]

[illegible]

[illegible]

3. Train Forest Service personnel to deal with news media and general public in matters of forest management, ex. herbicide application.

4. Need to survey each National Forest by District to determine the need for vegetation management.

A few technical problems and needs are:

1. Need to determine the role of herbicides in creating and maintaining biological diversity in southern forests.

2. Need to determine rates of herbicides and time of application for vegetation control in specific physiographic regions in the South.

3. Need to utilize herbicides for improving stand quality in naturally regenerated stands.

4. Need to continue fate studies for herbicides in the forest ecosystem.

5. Need to conduct studies that utilize the aerial application of herbicides in order to determine if it is a feasible management tool on National Forest lands.

In summary I do not anticipate any aerial application being conducted on Forest Service land in the South. However, I would like to see research conducted with aerial application because it does have some advantages.

Again, I will issue an invitation to members of the National Steering Committee on Aerial Application of Pesticides-Vegetation Management to visit the southern U.S. for the purpose of observing vegetation management methods and problems - both on public and private lands.

APPENDIX B
Paul Mistretta

NOTES FROM REGION 8
FOR THE
NATIONAL STEERING COMMITTEE
FOR AERIAL APPLICATION OF PESTICIDES -
VEGETATION MANAGEMENT
1990

Paul A. Mistretta

Program summary:

Information is presented in the form of abbreviated notes. I'll be glad to clarify any point further.

1) The regional process of developing programmatic vegetation management EISs is complete with the issuance of the Ozark/Ouachita document on March 5, 1990. Appeal process is not complete on any of the three documents.

   Among other points of note are the following:

   The program developed in the preferred alternatives includes vegetation management on 764,695 acres annually; of this 90,456 acres are allowed to be herbicidally treated.

   The EISs allow a larger herbicide program than at present in the Coastal Plain/Piedmont and Appalachian Mountain subregions while curtailing somewhat the current program in the Ozark/Ouachita Mountains.

   Only 2,900 of these acres may be done using aerial application.

   Broadcast ground application of herbicide, either manually or mechanically is severely curtailed in silviculture, though it is retained for wildlife treatments and rights-of-way.

   Emphasis is placed on using the lowest effective rate of the least environmentally and health sensitive herbicide.

   Reduction of the use of soil-active herbicides is strongly mandated.

   Approximately 100 mitigations are imposed; by far the largest method specific group is that which deals with herbicides (30+).

2) The risk analysis prepared as part of the EIS process shows aerial to be the safest method with regard to human health. All broadcast application fails under the environmental "biodiversity" criteria being used by "environmentalists". Neither the criteria or the standards under which failure is evaluated is codified for our analysis.

3) We were unable to give away 80 acres of demonstration turnkey Velpar ULW application in FY'89; no forest wished to be the first to reintroduce aerial application to the region.

4) One major FPM thrust is to incorporate mitigations in the EIS into prescriptions and general forest practice. This is being accomplished by:
    Training in conjunction with the ongoing regional restricted-use pesticide applicator certification training.
    Training at annual prescription schools.
    Ongoing evaluation of new products and tools which meet the mitigation needs of the forests.

5) Training is a major thrust. Two level certification: restricted use pesticide applicator certification and a new COR/Project Inspector Certification.

6) Major concerns, both internal and external, which are influencing our program include:
    - Endangered species
    - Diversity (as yet undefined, but a real catch all buzz word)
    - Application rates
    - Ground and potable water
    - Immunotoxicology and neurotoxicology (again buzz words, no protocols for evaluation are yet agreed on)
    - Cumulative effects

7) Currently involved in the national FPM FY'89 programmatic economic analysis.

8) Litigation and appeals are becoming a major drain on regional resources.

9) We are currently involved with Georgia Tech Research Institute and appropriate companies, in worker exposure studies on garlon 4 and roundup.

Program needs:

- Need some form of decision support or expert system to allow field level personnel produce environmental analyses which identify all applicable mitigations from the (at least) four separate EISs which apply to any parcel of land in the South. This program should resolve (or at least identify) conflicts where they occur.

- We need some form of a risk assessment program which will allow us to evaluate rates/times of exposure not permitted for use, but not shown to be hazardous in the EISs. This will allow truly site-specific analyses to be performed.

- Review available data on residual diversity (non-target survival) and identify major data gaps. Encourage and support research in this area.

- Need worker exposure studies on a few other herbicides to establish valid empirical modeling standards.

- Need an ongoing safety effort; including good training aids, equipment development or modification, clothing review and development, etc.

- Need some valid economics models to allow the projection of economic thresholds for control.

APPENDIX B
Ed Monnig

Report from Region 1
for the
National Steering Committee
For Aerial Application of Pesticides-
Vegetation Management
1990

Edward Monnig

INTRODUCTION

Last year's report from Region 1 noted the need for aerial application of herbicides to convert brushfields to fully stocked timberlands. Despite committments for this conversion in at least one Forest Plan, the Forests had yet to undertake the NEPA documentation. The situation remains the same at this time. Although the Forests are interested in the efforts of Regions 5 and 6 to complete the NEPA process for vegetation management activities, staff are somewhat skeptical that the process will be completed.

The Regional Office Timber/FPM staff remains committed to assist the Forests in completing the NEPA process on a site-specific basis. The RO has recently joined with Regions 2, 3, 4 and 10, in contracting for human health risk assessment for vegetation management activities. This assessment would be used as a background document for site-specific analysis. The Regional Office has also provided a Guide for Management of Problem Vegetation in Silvicultural Practices.

NEEDS AND ISSUES

In preparing this report the 1989 report by the National Steering Committee for Vegetation Management was reviewed. The needs and issues identified in the 1989 report remain remarkedly timely. In particular we would like to comment on four issues which seem very fundamental if progress is to be made in this area.

First, the role of various staff groups in the use of herbicides for vegetation management must be more clearly defined. In some cases FPM has assumed responsibility almost by default. Where responsibility is diffuse, it is often easy to defer the hard issues.

The lack of central staff role in herbicide management may also be associated with the lack central focus and organizational responsibility for herbicide research. It is apparent that research responsibility in the area of vegetation management and herbicide use must be assigned if progress is to be made on the other issues identified by the Steering Committee.

Second, increased information on the cost and benefit of herbicide use must be generated. In times of tight budgets, particularly with the escalating cost of NEPA compliance, line officers are demanding to know the benefits of a project or program before committing to extensive preparation.

Third, updated publications are needed to support training efforts and field use of herbicides for vegetation management. At the present time much of the institutional expertise in this area has disappeared.

Finally, the issue of biodiversity has become increasingly important in public comment on Forest activities. Herbicide use will likely be perceived as a threat to biodiversity. Increased research in this area is necessary to define the extent of this problem.

As noted above, the variety of other needs and issues identified by the Steering Committee are appropriate. The resolution of four identified above is particularly fundamental if progress is to be made in other issue areas and if committment is to be generated for these vegetation management activities.

APPENDIX B
Don Perala

Report to the National Steering Committee for Aerial Application of Pesticides-Vegetation Management

by

Donald A. Perala
Research Forester
North Central Forest Experiment Station
Grand Rapids, MN

7 March 1990

Sacramento, CA

Herbicide use/needs ha~~s~~ve not changed dramatically within Research Work Units in NCFES over the last year. Only a handful of scientists are conducting research relating to or requiring herbicides.

E. Hansen, Forestry Sciences Laboratory, Grand Rapids, MN, is conducting a 10-year pilot project with short rotation intensively cultured poplar plantations on several soil types over broad climatic conditions. The objective is to determine which poplar clones survive and grow best on specific soil types and under specific microclimates, and to determine if any clones survive and grow well over a wide range of environments. The sites are within the area bounded by the eastern edge of the Dakotas, to Michigan, and south into Iowa on agricultural cropland of average or better productivity with a medium texture. About 80 hybrid poplar clones were planted at each site, one replication in 1987 and a second replication in 1988. Roundup is used for site preparation to control quack grass and other perennials, and Linuron just prior to planting or up to 10 days thereafter. Linuron is used prior to leaf-on during the succeeding two years as needed. Simazine granules are handy for use at any time, but are expensive. They are safe for poplars that are 1+ years old and if the soil has more than 1.5% organic matter. Other herbicides used are Fusilade and Poast for summer direct spray for quack grass and foxtail. These herbicides are reasonably effective for establishing hybrid poplars on set-aside croplands.

D. Stone and A. Harris, Forestry Sciences Laboratory, Grand Rapids, MN, in May, 1989, began a three-year study on the fate of three soil active herbicides and their decomposition products under the influence of soil organic matter and rainwater acidity in low base-saturated sand soils treated with acidified rainwater. Leaching characteristics of ^{14}Carbon labeled hexazinone (Velpar), sulfometuron methyl (Oust), and tebuthiuron (Spike) at 1 gallon per acre of Velpar L, 2 ounces per acre of Oust, and 2.5 pounds per acre of Spike 80 W are being evaluated in 15 x 150 cm lysimeters. Treatments include one of three organic matter (litter-humus) levels: sand (control), jack pine, or mixed hardwood, and preconditioning with acidified rainwater at pH 5.4 or 4.2 for four years. The combination of soil texture, low base- saturation, and preconditioning with acid precipitation provide "worst case" conditions for the upper Great Lakes region. Rainwater is collected from a greenhouse roof, acidified with nitric and sulfuric acids, and applied at an annual rate of 800 mm. ~~The herbicides were spiked with ^{14}Carbon labeled material and applied at ordinary rates.~~ The three organic matter treatments, two acidity levels, three herbicides, and six replications require 108 lysimeters. One-third of the columns will be broken down after each of three seasons and analyzed to determine the distribution and activity of herbicides and metabolites. On week 7, after about 9 inches of rainwater had been applied, traces of ^{14}C-labeled products were detected in leachate from 22% of the columns treated with Velpar and from one of the columns treated with Spike. After 9 weeks of treatment and nearly 12 inches of water, ^{14}C-labeled compounds were detected in 72% of the columns treated with Velpar and 22% of those treated with Spike. After 17.6 inches of rainwater over a 14-week period, ^{14}C activity was detected in leachate from 97% of the Velpar columns and 64% of Spike columns. Actual precipitation recorded

during the 14 weeks was 12.26 inches. Of the 1,080 leachate samples from the 150 cm level that have been analysed, ^{14}C activity has been detected in only 96 samples and levels are very low. The ^{14}C-labeled compounds that have been detected probably are metabolites rather than parent compounds that have relatively short half-lives. No labeled compounds have been detected in leachate collected at 150 cm from the columns treated with Oust. Of the leachate collected at the 10, 20, and 40cm levels, only the 20 cm level has been analysed for ^{14}C activity; labeled compounds were detected in columns treated with all three products. Apparently most of the chemicals remain in the upper soil. Concentrations of parent compounds and metabolites in all ^{14}C labeled leachate and soil samples are still being determined.

H. M. Rauscher (Forestry Sciences Laboratory, Grand Rapids, MN) and M. Butler-Fasteland (U. MN) have developed a prototype advisory system for herbicide selection and application method. A version will be available for users by Fall 1990.

B. Haissig, Forestry Sciences Laboratory, Rhinelander, WI, recently presented a paper at the AAAS annual meeting in New Orleans that described how gene splicing of Salmonella into Populus can produce Roundup-resistant seedlings. The wire services picked the story up and it was widely disseminated.

APPENDIX B
Mike Rutty

POTENTIAL AERIAL HERBICIDE APPLICATION NEEDS IN THE CENTRAL SIERRA NEVADAS

1. Aerial application of glyphosate on bearclover. It has been said that this is not an effective application, but I have not seen any real evidence of that. (Nor have I seen any evidence that it would be a good application). Suggest that this be examined. Should also be examined in conjunction with potential adjuvants. There may be a working combination.

2. Registration of Escort (which showed a lot of promise) has been dropped or at least greatly delayed. We may wish to encourage its registration. (Note that while the R5 EIS for herbicide use in reforestation discussed 13 or more herbicides we are now down to using four).

3. The Dupont formulation of ULW velpar shows tremendous potential for use. The Stanislaus is very serious in wanting to be a customer for this formulation. It fits perfectly with the site prep we will need to do on the burn especially the holding action we are considering on the steep grounds.

4. There have been some minor efforts in the past to determine what the optimum pressure bomb readings could or should be on target and retention species at the time of an application of herbicides. (This may not even be significant but at this point we don't really know). This may have the potential to yield very useful data?

5. A few years ago there was a commotion over "laser" herbicides. Where are we with these? Is there a potential for such things? How far in the future?

6. "New Perspectives in Forestry" is going to cause a lot of changes in the near future. It may be that we'll see greatly reduced ability to use aerial applications at least for foliar active applications, but soil active agents may still be possible.

a. In partial cut stands where a mix of species is present, will aerial applications take out all sensitive trees of all sizes?

b. With an aerial application of a granular formula in such a stand can we hit an acceptable amount of the target brush?

c. Someone needs to consider the implications of this on ground applications. IE. Spot gun treatments, ground based machine applications, and hand applications. Worker safety, efficacy, effects on non target species. Some real fine tuning will be needed on these types of projects.

7. Training. Region 5 made a good effort last year in the training of people for pesticide applications. This needs to continue. We need continuing education requirements in our certification standards. The Service, the Region and the Forests need to actively continue with followup training. There are subjects which need to be addressed in greater depth along with new topics which are arising.

8. Computer modeling. A computer model which when fed the chemical to be used and all the target and non target species present on site along with site parameters would yield estimates of damage to the various species. We usually have a good idea of the effect on the primary target species and the on site commercial conifers, but the other species (as well as some of the target species) are rapidly becoming more and more significant as considerations when planning herbicide applications. With ground applications we can usually manage by avoidance. This is a lot more difficult with aerial applications.

APPENDIX B
Fay Shon

Pacific Northwest Region Report for 1989
to the National Steering Committee
(Vegetation Management)

ing 1989 the Pacific Northwest Region entered into a court ordered mediation n the final EIS for Managing Competing and Unwanted Vegetation (EIS). On May 4, 1989, a Mediated Agreement was signed by three parties and the Forest rvice. The Mediated Agreement provided further detail on how the Record of ision (ROD) for the final EIS was to be implemented. In conjunction with he ROD and Mediated Agreement, the Region has begun to implement the final , with the exception of chemical alternatives. Chemical alternatives are rently prohibited by an administrative stay which will not be resolved until ll administrative appeals have been completed.

implement the ROD and Mediated Agreement a guide, entitled "A Guide to onducting Vegetation Management Projects in the Pacific Northwest Region" Guide), has been developed. The Guide incorporates existing direction from h the ROD and Mediated Agreement. The six chapters included are: 1) Site ecific Environmental Analysis; 2) Public Involvement - Working with People;) Worker Health - Protection and Reporting; 4) Working with Cooperators; 5) itoring; and 6) Information Packages for available herbicides and five atment methods. Among the new provisions are a form for contractors to eport health effects (Forest Service employees continue to use forms CA-1 and A-2) and a provision for maintaining health effects records for 30 years. The de also provides direction for implementing the preferred alternative in the S, prevention, and describes four other vegetation management strategies: arly treatment, maintenance, correction, and no action.

addition to developing the Guide, Region Six Forest Pest Management has rovided information and briefing sessions to the National Forests, outside operators, other federal and state agencies, and continues to meet with the gners of the Mediated Agreement.

Current research needs in the vegetation management area include decision king models to predict outcomes from selecting various types of vegetation agement methods or combination of methods, and evaluation of various egetation management techniques.

APPENDIX B
Larry Yarger

REGION 9 NOTES
STEERING COMMITTEE MEETING - VEGETATION MANAGEMENT
SACRAMENTO, CA
Larry Yarger
Forest Pest Management
NA-S&PF/Region 9

March 7-8, 1990

NTRODUCTION

n the Eastern Region, herbicides are prescribed for use primarily to release onifer stands, prepare sites for planting or seeding, and to establish and aintain permanent or wildlife openings. Additional reasons for using erbicides include: general weed control around structures and in campgrounds, anagement of range vegetation and noxious weeds, improvement of aquatic and parian habitats, nursery management, and maintrenance of road, trail and tility rights-of-way.

etween 1981 and 1989, the number of acres treated on National Forests in egion 9, using both aerial (1981-83) and ground methods, ranged between 12,188 nd 26,000 acres annually. In 1988, Forests treated 15,790 acres, and in 1989, total of 12,188 acres were treated. The decline in the number of acres eated with herbicides over the past several years is attributed, at least artially, to a reduction in the number of acres converted from hardwoods to onifers in accordance with current direction in Forest Plans. Between 1981 nd 1989, the number of acres of conifer plantations treated with herbicides to elease the growing stock from competing vegetation ranged between 4,599 and 4,200 annually. Acres treated for site preparation decreased from highs of 100 in 1982; 4,000 in 1983; and 4,400 in 1985, to 1,713 to 2,300 annually etween 1986 and 1989.

uring the several years immediately preceding the nationwide deferment of all erial applications of herbicides in March, 1984, aerial projects were onducted annually on several Forests in the Lake States area. The primary bjective of these projects were to release conifer plantations and prepare ites for planting and seeding. A few permittees, with rights-of-way in the ountainous terrain of the Monongahela National Forest in West Virginia, and ayne National Forest in Ohio, also have applied herbicides aerially.

/ A Committee Member Report to the National Steering Committee for Aerial Application of Pesticides - Vegetation Management, Sacramento, CA, March 7-8, 1990.

982 and 1983, aerial applications accounted for 22 percent and 37 percent spectively, of the total number of acres treated in the Region. The primary thod of applying herbicides aerially involved helicopters equipped with pped with raindrop nozzles. The primary herbicide applied aerially were ulations of glyphosate, hexazinone, and 2,4-D.

e 1984, Forests have pursued development and evaluation of ground ication techniques. The deferment of aerial application of herbicides can viewed as "igniting" interest in ground application techniques in the ion. However, just as motivating was the building interest in developing ication techniques that were "sensitive" to multi-resource values. niques that allowed more flexibility in the degree of herbicide coverage re being viewed as more "integrated." Strip, spot, and thinline treatments being considered and evaluated as possible alternatives to broadcast tments. Actually, resource values other than timber, such as wildlife, but so visual and aesthetic values, were receiving increased emphasis during the scription process.

eral Forests are now using mechanized equipment designed to apply herbicides conifer plantations in "strips." Through the use of strip treatments, or ding, Forests are striving to maintain vegetative cover valuable to wildlife le reducing the amount of vegetation directly competing with seedlings. ot and thinline treatments are also receiving considerable interest. Forests encouraging permittees to consider treatment prescriptions that allow reased selectivity in the areas and types of vegetation treated, rather than oadcast applications. In addition to the benefits to "other" resources, the blic views ground application methods as more acceptable than aerial methods, environmentally and socially.

e Eastern Region has essentially transited from a Region that considered the of aerial equipment a viable vegetation management alternative, to one that relies entirely on ground application techniques. However, the Region sires to maintain the option of using aerial techniques on in-service ojects, and to be in a position to allow permittees the option of using ial techniques to manage vegetation along utility rights-of-way. Before ial techniques can be "reinstated" as a viable alternative, a major "hurdle" r the Region from an administration standpoint, is the need to develop and ument an environmental analysis that considers aerial application hniques. The last environmental document prepared by the Region that scussed aerial techniques was issued in 1978. This document is dated, and longer considered a viable NEPA document. The Region has established eral Forest teams to address the NEPA compliance issue. The Allegheny NF s already issued their NOI; the Chippewa and Superior NF are proceeding to velop and EIS, as are the Chequamegon, Nicolet and Ottawa NFs.

at least the life of the current Forest Plans, the Region anticipates that latively few acres would be proposed for treatment using aerial techniques n if the aerial application alternative became viable. The reasons for this : 1) the number of acres proposed for treatment to release conifer antations or prepare sites for artificial regeneration is expected to ntinue a slight downward trend over the life of current Forest Plans, increased interest in non-broadcast application methods, 3) terrain is not a iting factor to the use of ground equipment in most of the Region ignificant exception are utility rights-of-way in southern Ohio and West ginia), and 4) public sensitivity to aerial methods. However, information surfacing as a result of human health risk assessments prepared in several

gions necessitates another evaluation of the viability of using aerial
chniques in Region 9.

Currently, Forests in the Region are not conducting pilot projects, or field evaluations, of herbicides using aerial application equipment. However, the Region needs to stay current in aerial application technology, or be able to acquire aerial application expertise, in the event that this alternatives becomes viable. The Region expects that utility rights-of-way permittees will continue to request approval to use aerial methods in the mountainous areas of West Virginia and southern Ohio. We also expect State agencies, and industrial forest land owners, especially in the Lake States area, as well as several Federal agencies, will continue to apply herbicides aerially. Pilot tests in the use of aerial methods of applying herbicides would benefit these Forest Service cooperators, as well as provide valuable information in the event that the Region proposed the use of aerial treatments on National Forests.

The Region's primary concern is focused on the NEPA compliance issue. The Region has taken steps to address this issue with Forest teams, primarily in the Lake States area.

A summary of herbicide-use is enclosed. Several non-technical and technical needs are addressed below:

<u>Non-Technical Problems and Needs</u>:

(1) NEPA. The Region is moving toward compliance with NEPA. Several Forest teams are in the process of developing EIS's. The Regional Office is developing a human health and wildlife risk assessment.

(2) Benefits from Non-Aerial Methods. The advantage of using ground techniques over aerial techniques to selectively treat areas has received considerable interest on the part of Forests. By using selective treatments rather than broadcast treatment, resource values, in addition to the primary purpose for managing vegetation, can be achieved in treatment areas.

(3) Public Acceptance. For the most part, the public is more receptive to proposed herbicide applications when the method of application involves ground rather than aerial equipment.

<u>Technical Problems and Needs</u>:

(1) Technical Training and Technology Transfer. Several years of non-activity in the aerial application field has resulted in a degradation, or least stagnation, of technical skills. Forests have not kept up with state-of-the-art methods of applying herbicides aerially, nor basic project planning and administration procedures.

Forests have benefited from work accomplished by R8, NEFES, and NCFES.

(2) Evaluation Procedures. Forests need to state-of-the-art methodologies for conducting pre- and post-treatment evaluations.

SUMMARY OF PESTICIDE-USE IN REGION 9, 1986-89

PESTICIDE	1986 ACRES	1986 LBS. AI	1987 ACRES	1987 LBS. AI	1988 ACRES	1988 LBS. AI	1989 ACRES	1989 LBS. AI
FUNGICIDES & FUMIGANTS	346 250 lbs.	4,003 seed	197	2383	122	457	84	200
HERBICIDES & ALGICIDES	22,734	39,887	18,578	30,324	15,790	17,139	12,188	19,387
INSECTICIDES	419 29.7M BIUs	118	35,945 541.8M BIUs	15	8,928 142.2M BIUs	40	43,073 456.7M BIUs	625
PISCICIDES	2	5	3	5	0	0	0	0
REPELLANTS & RODENTICIDES	0 142 lbs. seed	2	0 80 lbs. seed	16	0 65 lbs. seed	0	0 50 lbs. seed	3
TOTAL USE	23,501 392 lbs. seed 3.5M BIUs	44,038	54,723 80 lbs. seed 541.8M BIUs	32,743	24,840 142.2M BIUs	24,643	55,345 50 lbs. seed 456.7M BIUs	20,215
HERBICIDE (major categories) 1/								
SITE PREPARATION	1,930	4,174	2,266	3,619	2,130	2,957	1,713	1,372
CONIFER RELEASE	11,851	12,393	7,589	10,376	6,957	9,457	4,599	5,331
RANGE MANAGEMENT & NOXIOUS WEEDS	1,161	552	629	457	944	603	1,112	836
WLD. HABITAT IMPROVEMENT	4,400	10,098	5,515	6,787	3,459	5,719	3,989	4,781
ROWS,ROADS & TRAILS	2,421	9,173	1,284	6,612	1,739	4,189	435	3,415
NURSERIES	24	43	68	212	32	138	18	3,340
SPITTLEBUG IPM	478	744	772	1,179	238	330	0	0

1/ Ground applications.

LYARGER 12/89

SUMMARY OF PESTICIDE-USE IN REGION 9, 1989 1/

ACRES TREATED BY FOREST

	ANF	CHF	CPF	GMF	HIF	HMF	MTF	MNF	NIF	OTF	SHF	SUF	WHF	WMF	TOTAL
FUNGICIDES & FUMIGANTS	0	0	0	0	0	0	0	2	0	82	0	0	0	0	84
HERBICIDES															
Aquatic Weeds 2/	0	0	0	0	0	0	7	4	0	0	0	0	0	0	11
Conifer Release	0	169	925	0	195	0	1838	0	989	416	0	0	67	0	4599
General Weed Control	0	0	0	0	2	0	0	6	212	0	0	0	0	0	220
Hardwood Release	0	0	0	0	0	0	61	0	0	0	0	0	0	0	61
Noxious Weeds	0	0	0	0	0	0	550	0	0	0	0	0	0	0	550
Nursery	0	0	0	0	0	0	0	0	0	18	0	0	0	0	18
Research	0	0	0	0	0	0	0	30	0	0	0	0	0	0	30
Range Management	0	0	0	0	0	0	442	0	0	0	0	0	120	0	562
Rights-of-Way	80	56	0	41	0	29	196	30	0	3	0	0	0	0	435
Site Preparation	1706	7	0	0	0	0	0	0	0	0	0	0	0	0	1713
Wildlife Improvements	0	394	49	0	0	0	3021	0	511	0	0	0	0	14	3989
SUBTOTAL HERBICIDES	1786	626	974	41	197	29	6115	70	1712	437	0	0	187	14	12188
INSECTICIDES 3/ (G)	0	0	0	0	0	0	0	1	31	16	0	0	84	0	132
(A)	42170	0	0	0	0	0	0	771	0	0	0	0	0	0	42941
SUBTOTAL INSECTICIDES	42170	0	0	0	0	0	0	775	31	16	0	0	84	0	43073
RODENTICIDES & REPELLANTS (pounds of seed)	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50
TOTAL ACRES TREATED	43956	626	974	41	197	29	6115	844	1743	535	0	0	271	14	55345
POUNDS OF SEED TREATED	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50

1/ Compiled from FS 2100-1 forms.
2/ Includes algicides.
3/ A=Aerial applications.
G=Ground applications.

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HERBICIDE-USE IN REGION 9, 1986-89

HERBICIDE	1986	1987	1988	1989	(lbs. A.I. in 1989)
	ACRES TREATED				
AMITROLE	4	0	0	0	0
AMMONIUM SULFAMATE	414	530	525	32	112
ATRAZINE	80	45	140	313	314
ATRAZINE/GLYPHOSATE	0	20	0	0	0
BIFENOX	14	15	0	0	0
BROMACIL/DIURON	0	96	10	80	480
CACODYLIC ACID	8	0	0	0	0
COPPER TRIETHANOLAMINE	0	0	0	1	1
DALAPON	12	0	0	0	0
DACTHAL	0	2	0	0	0
DICAMBA	38	41	8	10	2
DICAMBA/2,4-D	0	2	3	0	0
DICHLOBENIL	1	0	0	0	0
DIQUAT	10	0	0	0	0
DIURON	90	0	1	24	24
DIURON/ATRAZINE	0	0	3	0	0
DIURON/OUST	0	0	0	1	2
ENDOTHALL	47	81	0	0	0
FOSAMINE AMMONIUM	12	362	426	136	2415
GLYPHOSATE	3241	2110	3706	2658	3656
GLYPHOSATE/ATRAZINE	0	0	25	0	0
GLYPHOSATE/OUST	216	220	21	442	473
GLYPHOSATE/SIMAZINE	1	0	0	0	0

HERBICIDE-USE IN REGION 9, 1986-89 continued

	ACRES TREATED				
HERBICIDE	1986	1987	1988	1989	(lbs. A.I. in 1989)
HEXAZINONE	7300	7430	4417	3289	4081
HEXAZINONE/OUST	0	2	0	0	0
IMAZPYR	0	4	10	10	10
LINURON	15	0	0	0	0
MCPA	85	0	0	85	170
MEFLUIDIDE	1	0	0	0	0
MEFLUIDIDE/DICAMBA	24	0	0	0	0
METOLACHLOR	15	0	0	0	0
MINERAL SPIRITS	0	0	0	7	3320
NAPROPAMIDE	0	35	0	3	14
OUST	1082	511	425	512	73
OXYFLUORFEN	4	6	0	3	2
PICLORAM	1782	733	475	293	105
PICLORAM/FOSAMINE AMMONIUM	0	7	12	0	0
PICLORAM/2,4-D	3817	2629	2454	1599	770
PICLORAM/2,4-D/ TRICLOPYR	323	334	514	0	0
PICLORAM/2,4-DP/ TRICLOPYR	40	0	0	0	0
SIMAZINE	18	9	13	4	8
SETHOXYDIN	0	10	0	3	1
TEBUTHIURON	244	492	729	677	510
TRICLOPYR	1522	1347	765	1209	996
TRICLOPYR/2,4-D	10	10	29	5	15
TRICLOPYR/PICLORAM	0	185	0	45	205
2,4-D	1309	943	1114	609	1507

HERBICIDE-USE IN REGION 9, 1986-89 continued

HERBICIDE	ACRES TREATED 1986	1987	1988	1989	(lbs. A.I. in 1989)
2,4-D/2,4-DP	574	123	30	32	40
2,4-D/2,4-DP/DICAMBA	18	5	100	106	81
2,4-D/2,4-DP/TRICLOPYR	182	133	0	0	0
2,4-DP	0	0	25	0	0

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REGION 9 NOTES
STEERING COMMITTEE MEETING - VEGETATION MANAGEMENT
SACRAMENTO, CA
Larry Yarger
Forest Pest Management
NA-S&PF/Region 9

March 7-8, 1990

NTRODUCTION

n the Eastern Region, herbicides are prescribed for use primarily to release ifer stands, prepare sites for planting or seeding, and to establish and aintain permanent or wildlife openings. Additional reasons for using erbicides include: general weed control around structures and in campgrounds, agement of range vegetation and noxious weeds, improvement of aquatic and arian habitats, nursery management, and maintrenance of road, trail and tility rights-of-way.

ween 1981 and 1989, the number of acres treated on National Forests in egion 9, using both aerial (1981-83) and ground methods, ranged between 12,188 nd 26,000 acres annually. In 1988, Forests treated 15,790 acres, and in 1989, otal of 12,188 acres were treated. The decline in the number of acres eated with herbicides over the past several years is attributed, at least artially, to a reduction in the number of acres converted from hardwoods to ifers in accordance with current direction in Forest Plans. Between 1981 1989, the number of acres of conifer plantations treated with herbicides to elease the growing stock from competing vegetation ranged between 4,599 and 200 annually. Acres treated for site preparation decreased from highs of 00 in 1982; 4,000 in 1983; and 4,400 in 1985, to 1,713 to 2,300 annually etween 1986 and 1989.

ring the several years immediately preceding the nationwide deferment of all ial applications of herbicides in March, 1984, aerial projects were onducted annually on several Forests in the Lake States area. The primary jective of these projects were to release conifer plantations and prepare es for planting and seeding. A few permittees, with rights-of-way in the ountainous terrain of the Monongahela National Forest in West Virginia, and ayne National Forest in Ohio, also have applied herbicides aerially.

A Committee Member Report to the National Steering Committee for Aerial Application of Pesticides - Vegetation Management, Sacramento, CA, March 7-8, 1990.

In 1982 and 1983, aerial applications accounted for 22 percent and 37 percent respectively, of the total number of acres treated in the Region. The primary method of applying herbicides aerially involved helicopters equipped with equipped with raindrop nozzles. The primary herbicide applied aerially were formulations of glyphosate, hexazinone, and 2,4-D.

Since 1984, Forests have pursued development and evaluation of ground application techniques. The deferment of aerial application of herbicides can be viewed as "igniting" interest in ground application techniques in the Region. However, just as motivating was the building interest in developing application techniques that were "sensitive" to multi-resource values. Techniques that allowed more flexibility in the degree of herbicide coverage were being viewed as more "integrated." Strip, spot, and thinline treatments were being considered and evaluated as possible alternatives to broadcast treatments. Actually, resource values other than timber, such as wildlife, but also visual and aesthetic values, were receiving increased emphasis during the prescription process.

Several Forests are now using mechanized equipment designed to apply herbicides in conifer plantations in "strips." Through the use of strip treatments, or banding, Forests are striving to maintain vegetative cover valuable to wildlife while reducing the amount of vegetation directly competing with seedlings. Spot and thinline treatments are also receiving considerable interest. Forests are encouraging permittees to consider treatment prescriptions that allow increased selectivity in the areas and types of vegetation treated, rather than broadcast applications. In addition to the benefits to "other" resources, the public views ground application methods as more acceptable than aerial methods, both environmentally and socially.

The Eastern Region has essentially transited from a Region that considered the use of aerial equipment a viable vegetation management alternative, to one that now relies entirely on ground application techniques. However, the Region desires to maintain the option of using aerial techniques on in-service projects, and to be in a position to allow permittees the option of using aerial techniques to manage vegetation along utility rights-of-way. Before aerial techniques can be "reinstated" as a viable alternative, a major "hurdle" for the Region from an administration standpoint, is the need to develop and document an environmental analysis that considers aerial application techniques. The last environmental document prepared by the Region that discussed aerial techniques was issued in 1978. This document is dated, and no-longer considered a viable NEPA document. The Region has established several Forest teams to address the NEPA compliance issue. The Allegheny NF has already issued their NOI; the Chippewa and Superior NF are proceeding to develop and EIS, as are the Chequamegon, Nicolet and Ottawa NFs.

For at least the life of the current Forest Plans, the Region anticipates that relatively few acres would be proposed for treatment using aerial techniques even if the aerial application alternative became viable. The reasons for this are: 1) the number of acres proposed for treatment to release conifer plantations or prepare sites for artificial regeneration is expected to continue a slight downward trend over the life of current Forest Plans, 2) increased interest in non-broadcast application methods, 3) terrain is not a limiting factor to the use of ground equipment in most of the Region (significant exception are utility rights-of-way in southern Ohio and West Virginia), and 4) public sensitivity to aerial methods. However, information now surfacing as a result of human health risk assessments prepared in several

ions necessitates another evaluation of the viability of using aerial techniques in Region 9.

rently, Forests in the Region are not conducting pilot projects, or field valuations, of herbicides using aerial application equipment. However, the egion needs to stay current in aerial application technology, or be able to ire aerial application expertise, in the event that this alternatives ecomes viable. The Region expects that utility rights-of-way permittees will ontinue to request approval to use aerial methods in the mountainous areas of Virginia and southern Ohio. We also expect State agencies, and industrial st land owners, especially in the Lake States area, as well as several ederal agencies, will continue to apply herbicides aerially. Pilot tests in use of aerial methods of applying herbicides would benefit these Forest ice cooperators, as well as provide valuable information in the event that he Region proposed the use of aerial treatments on National Forests.

Region's primary concern is focused on the NEPA compliance issue. The egion has taken steps to address this issue with Forest teams, primarily in he Lake States area.

ummary of herbicide-use is enclosed. Several non-technical and technical eeds are addressed below:

Non-Technical Problems and Needs:

(1) NEPA. The Region is moving toward compliance with NEPA. Several Forest teams are in the process of developing EIS's. The Regional Office is developing a human health and wildlife risk assessment.

(2) Benefits from Non-Aerial Methods. The advantage of using ground techniques over aerial techniques to selectively treat areas has received considerable interest on the part of Forests. By using selective treatments rather than broadcast treatment, resource values, in addition to the primary purpose for managing vegetation, can be achieved in treatment areas.

(3) Public Acceptance. For the most part, the public is more receptive to proposed herbicide applications when the method of application involves ground rather than aerial equipment.

. Technical Problems and Needs:

(1) Technical Training and Technology Transfer. Several years of non-activity in the aerial application field has resulted in a degradation, or least stagnation, of technical skills. Forests have not kept up with state-of-the-art methods of applying herbicides aerially, nor basic project planning and administration procedures.

Forests have benefited from work accomplished by R8, NEFES, and NCFES.

(2) Evaluation Procedures. Forests need to state-of-the-art methodologies for conducting pre- and post-treatment evaluations.

SUMMARY OF PESTICIDE-USE IN REGION 9, 1986-89

PESTICIDE	1986 ACRES	1986 LBS. AI	1987 ACRES	1987 LBS. AI	1988 ACRES	1988 LBS. AI	1989 ACRES	1989 LBS. AI
FUNGICIDES & FUMIGANTS	346 250 lbs.	4,003 seed	197	2383	122	457	84	200
HERBICIDES & ALGICIDES	22,734	39,887	18,578	30,324	15,790	17,139	12,188	19,387
INSECTICIDES	419 29.7M	118 BIUs	35,945 541.8M BIUs	15	8,928 142.2M BIUs	40	43,073 456.7M BIUs	625
PISCICIDES	2	5	3	5	0	0	0	0
REPELLANTS & RODENTICIDES	0 142 lbs.	2 seed	0 80 lbs.	16 seed	0 65 lbs.	0 seed	0 50 lbs.	3 seed
TOTAL USE	23,501 392 lbs. 3.5M BIUs	44,038 seed	54,723 80 lbs. 541.8M BIUs	32,743 seed	24,840 142.2M BIUs	24,643	55,345 50 lbs. 456.7M BIUs	20,215 seed
HERBICIDE (major categories) 1/								
SITE PREPARATION	1,930	4,174	2,266	3,619	2,130	2,957	1,713	1,372
CONIFER RELEASE	11,851	12,393	7,589	10,376	6,957	9,457	4,599	5,331
RANGE MANAGEMENT & NOXIOUS WEEDS	1,161	552	629	457	944	603	1,112	836
WLD. HABITAT IMPROVEMENT	4,400	10,098	5,515	6,787	3,459	5,719	3,989	4,781
ROWS,ROADS & TRAILS	2,421	9,173	1,284	6,612	1,739	4,189	435	3,415
NURSERIES	24	43	68	212	32	138	18	3,340
SPITTLEBUG IPM	478	744	772	1,179	238	330	0	0

1/ Ground applications.

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SUMMARY OF PESTICIDE-USE IN REGION 9, 1989 1/

ACRES TREATED BY FOREST

	ANF	CHF	CPF	GMF	HIF	HMF	MTF	MNF	NIF	OTF	SHF	SUF	WHF	WMF	TOTAL
FUNGICIDES & FUMIGANTS	0	0	0	0	0	0	0	2	0	82	0	0	0	0	84
HERBICIDES															
Aquatic Weeds 2/	0	0	0	0	0	0	7	4	0	0	0	0	0	0	11
Conifer Release	0	169	925	0	195	0	1838	0	989	416	0	0	67	0	4599
General Weed Control	0	0	0	0	2	0	0	6	212	0	0	0	0	0	220
Hardwood Release	0	0	0	0	0	0	61	0	0	0	0	0	0	0	61
Noxious Weeds	0	0	0	0	0	0	550	0	0	0	0	0	0	0	550
Nursery	0	0	0	0	0	0	0	0	0	18	0	0	0	0	18
Research	0	0	0	0	0	0	0	30	0	0	0	0	0	0	30
Range Management	0	0	0	0	0	0	442	0	0	0	0	0	120	0	562
Rights-of-Way	80	56	0	41	0	29	196	30	0	3	0	0	0	0	435
Site Preparation	1706	7	0	0	0	0	0	0	0	0	0	0	0	0	1713
Wildlife Improvements	0	394	49	0	0	0	3021	0	511	0	0	0	0	14	3989
SUBTOTAL HERBICIDES	1786	626	974	41	197	29	6115	70	1712	437	0	0	187	14	12188
INSECTICIDES 3/ (G)	0	0	0	0	0	0	0	1	31	16	0	0	84	0	132
(A)	42170	0	0	0	0	0	0	771	0	0	0	0	0	0	42941
SUBTOTAL INSECTICIDES	42170	0	0	0	0	0	0	775	31	16	0	0	84	0	43073
RODENTICIDES & REPELLANTS (pounds of seed)	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50
TOTAL ACRES TREATED	43956	626	974	41	197	29	6115	844	1743	535	0	0	271	14	55345
POUNDS OF SEED TREATED	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50

1/ Compiled from FS 2100-1 forms.
2/ Includes algicides.
3/ A=Aerial applications.
G=Ground applications.

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HERBICIDE-USE IN REGION 9, 1986-89

ACRES TREATED

HERBICIDE	1986	1987	1988	1989	(lbs. A.I. in 1989)
AMITROLE	4	0	0	0	0
AMMONIUM SULFAMATE	414	530	525	32	112
ATRAZINE	80	45	140	313	314
ATRAZINE/GLYPHOSATE	0	20	0	0	0
BIFENOX	14	15	0	0	0
BROMACIL/DIURON	0	96	10	80	480
CACODYLIC ACID	8	0	0	0	0
COPPER TRIETHANOLAMINE	0	0	0	1	1
DALAPON	12	0	0	0	0
DACTHAL	0	2	0	0	0
DICAMBA	38	41	8	10	2
DICAMBA/2,4-D	0	2	3	0	0
DICHLOBENIL	1	0	0	0	0
DIQUAT	10	0	0	0	0
DIURON	90	0	1	24	24
DIURON/ATRAZINE	0	0	3	0	0
DIURON/OUST	0	0	0	1	2
ENDOTHALL	47	81	0	0	0
FOSAMINE AMMONIUM	12	362	426	136	2415
GLYPHOSATE	3241	2110	3706	2658	3656
GLYPHOSATE/ATRAZINE	0	0	25	0	0
GLYPHOSATE/OUST	216	220	21	442	473
GLYPHOSATE/SIMAZINE	1	0	0	0	0

HERBICIDE-USE IN REGION 9, 1986-89 continued

	ACRES TREATED				
HERBICIDE	1986	1987	1988	1989	(lbs. A.I. in 1989)
HEXAZINONE	7300	7430	4417	3289	4081
HEXAZINONE/OUST	0	2	0	0	0
IMAZPYR	0	4	10	10	10
LINURON	15	0	0	0	0
MCPA	85	0	0	85	170
MEFLUIDIDE	1	0	0	0	0
MEFLUIDIDE/DICAMBA	24	0	0	0	0
METOLACHLOR	15	0	0	0	0
MINERAL SPIRITS	0	0	0	7	3320
NAPROPAMIDE	0	35	0	3	14
OUST	1082	511	425	512	73
OXYFLUORFEN	4	6	0	3	2
PICLORAM	1782	733	475	293	105
PICLORAM/FOSAMINE AMMONIUM	0	7	12	0	0
PICLORAM/2,4-D	3817	2629	2454	1599	770
PICLORAM/2,4-D/ TRICLOPYR	323	334	514	0	0
PICLORAM/2,4-DP/ TRICLOPYR	40	0	0	0	0
SIMAZINE	18	9	13	4	8
SETHOXYDIN	0	10	0	3	1
TEBUTHIURON	244	492	729	677	510
TRICLOPYR	1522	1347	765	1209	996
TRICLOPYR/2,4-D	10	10	29	5	15
TRICLOPYR/PICLORAM	0	185	0	45	205
2,4-D	1309	943	1114	609	1507

HERBICIDE-USE IN REGION 9, 1986-89 continued

HERBICIDE	ACRES TREATED 1986	1987	1988	1989	(lbs. A.I. in 1989)
2,4-D/2,4-DP	574	123	30	32	40
2,4-D/2,4-DP/DICAMBA	18	5	100	106	81
2,4-D/2,4-DP/TRICLOPYR	182	133	0	0	0
2,4-DP	0	0	25	0	0

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APPENDIX C

Scientific and Technical Exchange between the United States and the People's Republic of China on Forest Vegetation Management and Herbicide Science

April - May 1989

James H. Miller
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EXECUTIVE SUMMARY

The objective of the technical exchange was a two-way sharing of information on forest vegetation management practices and the uses of herbicides in forestry, including application technology. Central to the exchange were two seminars: a national-scope seminar held at the Southwest Forestry College in Kunming, Yunnan Province, and a regional-scope seminar held at Nanjing Forestry University in Nanjing, Jiangsu Province. Miller and his interpreter, Professor Qiu Zhongzu, delivered a total of 55 hours lecture at the two seminars.

Information on China was gained through site visits and tours of forested areas, research institutes, and universities, along with presentations by researchers attending the seminars. The seminar outline is given in Appendix 1 and the trip itinerary in Appendix 2.

The major results and observations of the exchange are:

> China continues to harvest more forests than are being successfully established. Reforestation has only been successful on about 17% of the lands planted during the last 40 years. In the southern forest region, firewood harvesting and over grazing by villages are stymieing most afforestation and reforestation efforts. Yunnan Province was 33% forested in 1957 and was only 12% forested in 1984.
>
> Herbicides are increasingly being used in forestry for maintenance of firebreaks, weeding tree nurseries, and plantation establishment of fast-growing species. As in the U.S., proper usage is being learned through trial-and-error applications by user groups and through some excellent but meager research by a handful of scientists. Many researchers in the area of plant protection are eager to learn about herbicides and application techniques--many attended the seminars. The economics of all the research presented at the seminars shows that herbicide applications are 3 to 10 times cheaper than hand labor for all uses. Most uses are for herbaceous weed control while woody plant control is foreign to China because of the high utilization of fuelwood.

There is interest to publish a translation of "A manual on ground applications of forestry herbicide - edited by Miller and Mitchell" in China, to aid development and to guide proper application procedures. A preliminary translation was presented to seminar participants. A formal publication will probably require cooperative financial assistance.

The chinese have developed application techniques using wicks and wipers which should have promise in the U.S. to decrease herbicide costs.

Cooperative contacts were made at both Southwest Forestry College and Nanjing Forestry University to assist in identifying biological control agents for kudzu, a native species of China. If established, these cooperative efforts should result in considerable cost savings for the biological control program just getting started in the southern U.S. China has been involved with biological control of imported weeds for over 10 years and are well versed in this area.

Many valuable examples were seen on growing shrub crops between tree rows to minimize competition and for gaining early cash returns for the farmer. These practices need to be explored in the South.

On a global perspective, air and water pollution goes unabated in China, causing increasing environmental deterioration. Contributions of atmospheric agents and elimination of mitigating influences that control global warming are obvious in China.

China is in need of more technical exchange visits from forestry scientists and managers to assist them in their massive reforestation effort. Much research is needed in all aspects of regeneration, especially on mountainous sites. Managers could assist in organizing their resources to be successful in these efforts. The visits need to be for extended time periods in order to assure that projects get started adequately. Without this in-country assistance it is difficult to see a desperate situation of declining wood supplies, turning around.